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Volume Loss and Grade Change of Hardwood Lumber During Air-Drying

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ABSTRACT. Tabulated data are presented for 10 hardwood species showing how green lumber changes in volume and grade when seasoned to the rough air-dried condition.

VOLUME LOSS AND GRADE CHANGE OF HARDWOOD LUMBER DURING AIR-DRYING

INTRODUCTION

Sawmill operators are often confronted with the task of estimating lumber output. They know the relationship of log grade and scale to product recovery, and they know the effect of a given log size on the cost of producing that lumber. But once the logs have been sawed and the green lumber stacked on the drying yard, what can they expect in terms of volume and grade when that lumber has air-dried?

To answer this question, nearly 782 thousand board feet of hardwood lumber were analyzed for changes in grade and volume between the rough green and rough air-dry conditions. Percent volume of lumber recovered after drying is tabulated by lumber grade and thickness for ten species.

SOURCE OF DATA

During the past ten years, a series of studies were conducted to accumulate lunber grade yields for hardwood trees and logs. In these studies, sample logs were sawed to obtain the greatest yield of lumber of the highest grades. The thickness pattern of the sawn lumber was consistent with log size and grade, and with market requirements at the time of the study. The data used in this report were extracted from these studies.

Green lumber was measured with a dry board rule and graded by an inspector from the National Hardwood Lumber Association (NHLA). Each board was tallied by identification number, thickness, surface measure, and grade. The lumber was then box-piled and stored on the drying yard. Proper alignment of stickers and bolsters was maintained and lumber piles were covered to protect them from weathering.

After the piles had air-dried for 90 to 120 days (18 to 22 percent average moisture content), each board was remeasured with a dry board rule and graded by the same NHLA inspector who graded the lumber in the green condition. The recorded dry tally included identification number, thickness, surface measure, and grade.

Data from the different mills were combined for each species and machine-processed. Surface measure was converted to board feet, and green and dry volumes were summed for each lumber grade and thickness class. Volume of dry lumber was then converted to percent of green volume and this figure rounded to the nearest whole percent.

RESULTS AND DISCUSSION

Percent volume of lumber recovered after air-drying is tabulated by species, lumber grade, and thickness in tables 1 through 10. Volume lost during drying is also given for each lumber grade-thickness class within species.

Table 11 shows the over-all volume loss by species as well as the range between mills. Species averages were lowest (3 percent) for red maple, sugar maple, black oak, and scarlet oak. Five species lost 4 percent of their original green volume during drying, whereas white oak showed the highest average loss with 5 percent.

The total loss in board foot volume between green and dry conditions is directly related to shrinkage in drying. However, part of this loss occurs because some boards are scant in width and thickness when manufactured, and the shrinkage from air-drying causes the board to fall into a lower width or thickness class. Although the loss in volume in this latter category is relatively small, much of it can be prevented. Proper maintenance of equipment and more accurate sawing and edging will insure adequate thickness and minimum width of dry material.

The volume of lumber that did not change grade during air-drying ranged from 76 to 86 percent of green volume for the 10 species. Seven to fourteen percent degraded at least one grade, and 2 to 6 percent was regraded to a higher grade after drying (table 11).

Most of the lumber degrade noted in the tables can be explained by seasoning defects. Such defects as warp, checks, and splits are caused by uneven drying and shrinkage due to a lack of uniformity in the structure of the wood. Some of the degrade was caused by shrinkage in board width. NHLA rules for the inspection of hardwood lumber specify minimum dry widths for FAS and FAS1F (6-inches), Selects (4-inches), and Commons (3-inches). Boards cut green just wide enough to meet these minimum specifications may shrink sufficiently to cause a size change and drop in grade.

The percent volume of lumber that went up one or more grades after drying reflects the difficulty in grading green lumber especially for marginal boards. Furthermore, certain types of defects (shake, wetwood, stain) are more difficult to evaluate in the green condition than they are in the dry, and the area and severity may be over estimated. This is one reason why most transactions in the hardwood market are in air-dry lumber. It is also possible for lumber to increase in grade during air-drying because of shrinkage. If a board shrinks to a lower surface measure, the total requirements for clear cutting units are reduced, and the board may qualify for a higher grade but at the lower surface measure.

Data on volume loss and grade change developed in this report are averages of a number of hardwood sawmill operations in the East. For any given operation, these figures may be either a little high or a little low. If an operator has developed his own figures, then the results presented here can be used as a guide in comparing the efficiency of his operation with that of others. On the other hand, if he has not developed his own figures, the percentages given here, when applied to green lumber yields, will provide an accurate estimate of the volume and grade of lumber that can be expected in the air-dry condition.

Table 1.--Basswood - Volume of lumber recovered after air-drying by lumber grade and thickness

Rough green			Rough air-dry												
Lumber grade	Thickness	Volume	FAS 4/4	FAS 6/4	SELS 4/4	SELS 6/4	1C 4/4	1C 5/4	1C 6/4	2C 4/4	2C 6/4	3C 4/4	BG 4/4	Volume loss
		Bd. ft.	Percent											
FAS	4/4	3,778	78	--	15	--	2	--	--	--	--	--	--	5
	6/4	369	--	82	--	11	--	--	--	--	--	--	--	7
SELS	4/4	3,340	3	--	84	--	7	--	--	2	--	--	--	4
	6/4	668	--	--	--	84	--	--	10	--	--	--	--	6
1C	4/4	6,067	1	--	--	--	86	--	--	8	--	--	--	5
	6/4	504	--	--	--	5	--	3	83	--	1	--	--	8
2C	4/4	6,877	--	--	--	--	2	--	--	91	--	3	--	4
3C	4/4	2,031	--	--	--	--	--	--	--	3	--	93	1	3

Table 2.--Yellow Birch-Volume of lumber recovered after air-drying by lumber grade and thickness

Rough green		Rough air-dry																																
ber:	Thick-		FAS				FAS1F					SELS				1C				2C				3AC					3BC				BG		Volume
de	ness	Volume	4/4	5/4	6/4	10/4	3/4	4/4	5/4	6/4	10/4	3/4	4/4	5/4	6/4	3/4	4/4	5/4	6/4	3/4	4/4	5/4	6/4	3/4	4/4	5/4	6/4	8/4	3/4	4/4	5/4	8/4	4/4	5/4	loss
		Bd. ft.	Percent																																
S	4/4	3,734	80	--	--	--	--	5	--	--	--	--	1	--	--	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	5/4	3,028	1	88	--	--	--	--	2	--	--	--	--	3	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	6/4	500	--	13	78	--	--	--	--	4	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	10/4	624	--	--	--	95	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S1F	4/4	2,287	4	--	--	--	1	71	--	--	--	--	3	--	--	1	14	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	5/4	1,925	--	8	--	--	--	1	75	--	--	--	--	3	--	--	--	8	--	--	--	1	--	--	--	--	1	--	--	--	--	1	--	--	2
	6/4	608	--	--	--	--	--	--	14	80	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	10/4	403	--	--	--	--	--	--	--	--	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LS	4/4	912	1	--	--	--	--	--	--	--	--	3	77	--	--	1	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	5/4	309	--	--	--	--	--	--	9	--	--	--	--	84	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	3
	4/4	9,127	1	--	--	--	--	2	--	--	--	--	--	--	--	2	85	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	5/4	3,866	--	--	--	--	--	--	--	--	--	--	--	1	--	--	2	87	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	4
	6/4	712	--	--	2	--	--	--	--	2	--	--	--	--	--	--	--	8	83	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	3
	4/4	8,328	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	1	83	--	--	--	8	--	--	--	--	1	--	--	--	--	4
	5/4	3,240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	3	77	--	--	--	13	--	--	--	--	1	--	--	--	3
	6/4	287	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1	--	--	6	86	--	--	--	3	--	--	--	--	--	--	--	3
C	4/4	5,518	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	2	79	--	--	--	--	10	--	--	1	--	4
	5/4	1,312	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--	--	2	76	--	--	--	--	9	--	--	1	3
	8/4	390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	--	--	--	--	--	--	--
C	4/4	4,625	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	5	--	--	--	2	82	--	--	6	--	4
	5/4	669	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	2	79	--	--	14	2
	8/4	1,216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	--	--	--

Table 3.--Red Maple-Volume of lumber recovered after air-drying by lumber grade and thickness

Lumber grade	Rough green Thickness	Rough green Volume	Rough air-dry FAS 4/4	FAS 5/4	FAS 6/4	FAS 8/4	FAS1F 4/4	FAS1F 5/4	FAS1F 6/4	FAS1F 8/4	SELS 4/4	SELS 5/4	SELS 6/4	SELS 8/4	1C 4/4	1C 5/4	1C 6/4	1C 7/4	1C 8/4	2AC 3/4	2AC 4/4	2AC 5/4	2AC 6/4	2BC 3/4	2BC 4/4	2BC 5/4	2BC 6/4	3AC 3/4	3AC 4/4	3AC 5/4	3AC 6/4	3BC 3/4	3BC 4/4	3BC 5/4	Volume loss
		Bd. ft.	Percent																															
FAS	4/4	3,760	88	--	--	--	5	--	--	--	2	--	--	--	2	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	2
	5/4	1,220	2	83	--	--	--	3	--	--	--	1	--	--	--	1	--	--	--	--	--	2	--	--	--	5	--	--	--	--	--	--	--	3
	6/4	1,387	--	1	88	--	--	1	4	--	--	--	2	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
	8/4	2,050	--	--	--	93	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
FAS1F	4/4	3,471	8	--	--	--	89	--	--	--	4	--	--	--	4	--	--	--	--	--	1	--	--	--	1	--	--	--	--	--	--	--	--	2
	5/4	1,146	--	--	--	--	2	79	--	--	--	2	--	--	--	3	--	--	--	--	--	6	--	--	--	4	--	--	--	--	--	--	--	4
	6/4	955	--	--	3	--	--	1	84	--	--	--	4	--	--	--	2	--	--	--	--	--	1	--	--	--	2	--	--	--	--	--	--	--	3
	8/4	244	--	--	--	--	--	--	--	90	--	--	--	3	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
SELS	4/4	1,558	--	--	--	--	2	--	--	--	84	--	--	--	8	--	--	--	--	--	1	--	--	--	2	--	--	--	--	--	--	--	--	3
	5/4	773	--	--	--	--	--	--	--	--	3	89	--	--	--	3	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	3
	6/4	277	--	--	--	--	--	--	--	--	--	--	92	--	--	--	3	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	4
	8/4	864	--	--	--	--	--	--	--	--	--	--	--	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
1C	4/4	6,914	--	--	--	--	3	--	--	--	1	--	--	--	86	--	--	--	--	--	6	--	--	--	1	--	--	--	--	--	--	--	--	3
	5/4	2,074	--	--	--	--	--	2	--	--	--	1	--	--	3	84	--	--	--	--	--	6	--	--	--	1	--	--	--	--	--	--	--	3
	6/4	1,035	--	--	3	--	--	--	3	--	--	--	1	--	--	6	81	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	3
	8/4	702	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
2AC	4/4	9,608	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	1	86	--	--	--	6	--	--	--	2	--	--	--	--	3
	5/4	1,934	--	--	--	--	--	--	--	--	--	--	--	--	1	3	--	--	--	--	4	80	--	--	--	8	--	--	--	1	--	--	--	3
	6/4	459	--	--	--	--	--	--	3	--	--	--	--	--	--	--	4	--	--	--	--	32	45	--	--	3	--	--	--	1	1	--	--	11
2BC	4/4	7,285	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	4	--	--	-2	87	--	--	--	2	--	--	--	1	--	3
	5/4	1,738	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	15	--	--	3	71	--	--	--	4	--	--	--	3	3
3AC	4/4	1,954	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	--	--	--	7	--	--	1	77	--	--	1	5	--	3
	5/4	335	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	2	7	--	--	1	19	--	--	--	50	--	--	4	11	5
3BC	4/4	861	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	5	--	--	--	14	--	--	--	--	78	2

Table 4.--Sugar maple-Volume of lumber recovered after air-drying by lumber grade and thickness

Rough green			Rough air-dry																												
Lumber grade	Thickness	Volume	FAS			FAS1F			SELS				1C			2C			3AC			3BC				BG			Volume loss
			4/4	5/4	8/4	4/4	5/4	8/4	3/4	4/4	5/4	8/4	4/4	5/4	8/4	3/4	4/4	5/4	8/4	4/4	5/4	8/4	4/4	5/4	6/4	8/4	4/4	5/4	6/4	
		Bd. ft.	Percent																												
FAS	4/4	896	80	--	--	7	--	--	--	3	--	--	2	---	---	---	2-	--	--	3	--	--	1	--	--	--	--	--	--	2
	5/4	4,410	1	76	--	--	8	--	--	--	2	--	--	7	--	--	--	1	--	--	--	--	--	1	--	--	--	--	--	--	4
	8/4	988	--	--	74	--	--	12	--	--	--	3	--	--	6	--	--	--	1	--	--	2	--	--	--	--	--	--	--	--	2
FAS1F	4/4	795	1	--	--	80	--	--	--	5	--	--	6	--	--	--	3	--	--	1	--	--	2	--	--	--	--	--	--	--	2
	5/4	4,622	--	4	--	--	75	--	--	--	2	--	--	10	--	--	--	4	--	--	1	--	--	---	--	--	--	--	--	--	4
	8/4	1,878	--	--	2	--	--	86	--	--	--	--	--	--	5	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	2
SELS	4/4	1,210	--	--	--	1	--	--	1	82	--	--	6	--	--	--	4	--	--	2	--	--	2	--	--	--	--	--	--	--	2
	5/4	685	--	1	--	--	7	--	--	1	85	--	--	2	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	3
1C	4/4	5,619	--	--	--	--	--	--	--	1	--	--	82	--	--	--	9	--	--	3	--	--	2	--	--	--	--	--	--	--	3
	5/4	11,053	--	--	--	--	--	--	--	--	--	--	--	82	--	--	--	10	--	--	3	--	--	1	--	--	--	--	--	--	4
	8/4	3,288	--	--	--	--	--	1	--	--	--	--	--	--	79	--	--	--	17	--	--	2	--	--	--	--	--	--	--	--	1
2C	4/4	6,301	--	--	--	--	--	--	--	--	--	--	-1	--	--	1	84	--	--	7	--	--	3	--	--	--	--	--	--	--	3
	5/4	7,357	--	--	--	--	--	--	--	--	--	--	--	2	--	--	1	76	--	--	15	--	--	2	--	--	--	--	--	--	4
	8/4	1,664	--	--	--	--	--	--	--	--	--	--	--	--	6	--	--	--	82	--	--	7	--	--	--	4	--	--	--	--	1
3AC	4/4	4,943	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	81	--	--	12	--	--	--	--	--	--	--	3
	5/4	2,301	--	--	--	--	--	--	--	--	--	--	-1	--	--	--	--	5	--	1	75	--	--	14	--	--	--	--	--	--	4
	8/4	912	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	98	--	--	--	2	--	--	--	--	--
3BC	4/4	5,827	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	90	--	--	--	4	--	--	2
	5/4	1,074	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	84	--	--	--	13	--	2
	6/4	278	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	89	--	--	--	10	1
	8/4	2,850	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	--	--	--	--

Table 5.--Black Oak-Volume of lumber recovered after air-drying by lumber grade and thickness

Lumber grade	Thickness	Rough green Volume	Rough air-dry: FAS 4/4	FAS 5/4	FAS 6/4	FAS1F 4/4	FAS1F 5/4	FAS1F 6/4	SELS 3/4	SELS 4/4	SELS 5/4	1C 3/4	1C 4/4	1C 5/4	2C 3/4	2C 4/4	2C 5/4	SW 3/4	SW 4/4	SW 5/4	3AC 3/4	3AC 4/4	3AC 5/4	3BC 4/4	3BC 5/4	BG 4/4	BG 5/4	Volume loss
		Bd. ft.	Percent																								
FAS	4/4	580	75	--	--	14	--	--	--	1	--	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	2
	5/4	9506	2	81	--	--	10	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	2
	6/4	295	--	60	5	--	--	13	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	16
FAS1F	4/4	992	5	--	--	72	--	--	--	3	--	--	15	--	--	--	--	--	--	--	2	--	--	--	--	--	3
	5/4	6684	--	2	--	2	76	--	--	--	--	--	1	16	--	--	--	--	--	--	--	--	--	--	--	--	3
SELS	4/4	297	--	--	--	--	--	--	1	84	--	--	9	--	-	--	--	--	--	--	1	--	--	--	--	--	5
	5/4	1016	--	2	--	--	--	--	--	2	82	--	--	6	--	--	3	--	--	--	--	1	1	--	--	--	3
1C	4/4	7542	--	--	--	1	--	--	--	--	--	1	86	--	--	9	--	--	--	--	--	--	--	--	--	--	3
	5/4	14406	--	--	--	--	1	--	--	--	--	--	3	89	--	--	4	--	--	--	--	--	--	--	--	--	3
2C	4/4	8791	--	--	--	--	--	--	--	--	--	--	2	--	1	87	--	--	1	--	--	6	--	1	--	--	2
	5/4	5225	--	--	--	--	--	--	--	--	--	--	--	4	--	5	84	--	--	--	--	--	3	--	--	--	4
SW	4/4	2067	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	1	86	--	--	6	--	2	--	--	3
	5/4	590	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	6	80	--	1	8	--	--	--	3
3AC	4/4	6420	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	1	--	1	82	--	12	--	--	2
	5/4	910	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	14	77	1	1	--	6
3BC	4/4	2629	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	7	--	86	--	4	2
	5/4	281	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22	61	--	7	10

Table 6.--Chestnut Oak-Volume of lumber recovered after air-drying by lumber grade and thickness

| Rough green | | Rough air-dry | | |

Table 7.--Northern red oak-Volume of lumber recovered after air-drying by lumber grade and thickness

Rough green			Rough air-dry																											
Lumber grade	Thickness	Volume	FAS				FAS1F				SELS		1C			2C				3AC			3BC			BG		Volume loss
			3/4	4/4	5/4	6/4	3/4	4/4	5/4	6/4	4/4	5/4	4/4	5/4	6/4	3/4	4/4	5/4	6/4	3/4	4/4	5/4	3/4	4/4	5/4	4/4	5/4	
		Bd. ft.	Percent																									
FAS	4/4	8,861	1	73	--	--	--	10	--	--	2	--	10	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	3
	5/4	28,365	--	2	76	--	--	--	10	--	--	1	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
	6/4	5,570	--	--	5	77	--	--	--	11	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	4
FAS1F	4/4	7,549	--	14	--	--	1	55	--	--	1	--	24	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	3
	5/4	11,920	--	--	3	--	--	2	71	--	--	1	1	17	--	--	--	1	--	--	--	--	--	--	--	--	--	--	4
	6/4	1,312	--	--	--	22	--	--	11	47	--	--	--	4	9	--	--	--	1	--	--	--	--	--	--	--	--	--	6
SELS	4/4	2,251	--	1	--	--	--	3	--	--	74	--	16	--	--	--	2	--	--	--	1	--	--	--	--	--	--	--	3
	5/4	2,490	--	--	1	--	--	--	--	--	2	80	--	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3
1C	4/4	29,404	--	2	--	--	--	4	--	--	1	--	76	--	--	--	12	--	--	--	1	--	--	--	--	--	--	--	4
	5/4	20,386	--	--	--	--	--	--	2	--	--	--	4	82	--	--	1	7	--	--	--	--	--	--	--	--	--	--	4
	6/4	1,132	--	--	--	3	--	--	--	1	--	--	--	23	60	--	--	2	3	--	--	--	--	--	--	--	--	--	8
2C	4/4	28,386	--	--	--	--	--	--	--	--	--	--	8	--	--	1	76	--	--	--	11	--	--	1	--	--	--	--	3
	5/4	4,976	--	--	--	--	--	--	--	--	--	--	--	2	--	--	23	59	--	--	3	3	--	--	--	--	--	--	10
3AC	4/4	16,160	--	--	--	--	--	--	--	--	--	--	1	--	--	--	18	--	--	1	70	--	--	7	--	--	--	--	3
	5/4	1,099	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	4	--	--	27	38	--	10	7	--	--	--	12
3BC	4/4	7,698	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	18	--	1	69	--	7	--	--	3
	5/4	447	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	2	--	--	6	9	--	29	34	3	2	--	12

Table 8.--Scarlet oak-Volume of lumber recovered after air-drying by lumber grade and thickness

Rough green			Rough air-dry																							
Lumber grade	Thickness	Volume	FAS			FAS1F			SELS			1C			2C			3AC			3BC			BG	Volume loss
			5/8	4/4	5/4	5/8	4/4	5/4	5/8	4/4	5/4	5/8	4/4	5/4	5/8	4/4	5/4	5/8	4/4	5/4	5/8	4/4		4/4	
		Bd. ft.	Percent																						
FAS	5/8	1,288	82	--	--	2	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--	--	--	--	5
	4/4	923	--	77	--	--	7	--	--	3	--	--	10	--	--	--	--	--	--	--	--	--	--	--	3
	5/4	1,059	--	--	75	--	--	14	--	--	2	--	--	7	--	--	--	--	--	--	--	--	--	--	2
FAS1F	5/8	808	4	--	--	72	--	--	1	--	--	18	--	--	--	--	--	--	--	--	--	--	--	--	5
	4/4	715	--	9	--	--	70	--	--	3	--	--	12	--	--	3	--	--	--	--	--	--	--	--	3
	5/4	760	--	--	2	--	1	62	--	--	--	--	1	26	--	--	5	--	--	--	--	--	--	--	3
SELS	4/4	260	--	--	--	--	3	--	--	74	--	--	19	--	--	--	--	--	--	--	--	--	--	--	4
1C	5/8	5,323	--	--	--	2	--	--	--	--	--	91	--	--	2	--	--	--	--	--	--	--	--	--	5
	4/4	6,247	--	--	--	--	2	--	--	--	--	--	74	--	--	20	--	--	1	--	--	--	--	--	3
	5/4	1,535	--	--	--	--	--	6	--	--	--	--	--	79	--	1	11	--	--	1	--	--	--	--	2
2C	5/8	1,449	--	--	--	--	--	--	--	--	--	7	--	--	86	--	--	2	--	--	--	--	--	--	5
	4/4	10,496	--	--	--	--	--	--	--	--	--	--	3	--	--	85	--	--	8	--	--	1	--	--	3
	5/4	308	--	--	5	--	--	--	--	--	--	--	--	11	--	--	77	--	--	5	--	--	--	--	2
3AC	5/8	277	--	--	--	--	--	--	--	--	--	4	--	--	14	--	--	75	--	--	2	--	--	--	5
	4/4	11,072	--	--	--	--	--	--	--	--	--	--	--	--	--	6	--	--	82	--	--	9	--	--	3
3BC	4/4	7,328	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--	--	81	7	--	3

Table 9.--White Oak-Volume of lumber recovered after air-drying by lumber grade and thickness

| Rough green | | | Rough air-dry | | |

Table 10.--Yellow-poplar-Volume of lumber recovered after air-drying by lumber grade and thickness

Lumber grade	Rough green Thickness	Rough green Volume	Rough air-dry FAS 3/4	FAS 4/4	SELS 4/4	SELS 6/4	SAPS 4/4	SAPS 6/4	1C 3/4	1C 4/4	1C 6/4	1C 8/4	2AC 3/4	2AC 4/4	2AC 6/4	2AC 8/4	2BC 3/4	2BC 4/4	2BC 8/4	3C 4/4	3C 8/4	BG 4/4	BG 8/4	Volume loss
		Bd. ft.	Percent																					
FAS	4/4	1,434	1	66	15	--	3	--	--	11	--	--	--	1	--	--	--	--	--	--	--	--	--	3
SELS	4/4	1,511	--	5	50	--	5	--	--	33	--	--	--	4	--	--	--	--	--	--	--	--	--	3
	6/4	316	--	--	--	--	--	89	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	5
SAPS	4/4	3,836	--	2	32	--	41	--	--	20	--	--	--	2	--	--	--	--	--	--	--	--	--	3
	6/4	845	--	--	--	9	--	78	--	--	7	--	--	--	2	--	--	--	--	--	--	--	--	4
1C	4/4	24,543	--	--	1	--	--	--	1	82	--	--	--	11	--	--	--	1	--	--	--	--	--	4
	6/4	4,629	--	--	--	--	--	--	--	--	94	--	--	--	2	--	--	--	--	--	--	--	--	4
2AC	4/4	27,688	--	--	--	--	--	--	--	3	--	--	1	83	--	--	--	8	--	1	--	--	--	4
	6/4	2,547	--	--	--	1	--	--	--	--	5	--	--	--	90	--	--	--	--	--	--	--	--	4
2BC	4/4	17,633	--	--	--	--	--	--	--	--	--	--	--	5	--	--	1	87	--	3	--	--	--	4
	8/4	2,788	--	--	--	--	--	--	--	--	--	2	--	--	--	7	--	--	71	--	16	--	4	--
3C	4/4	1,843	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	5	--	71	--	18	--	3
	8/4	332	--	--	--	--	--	--	--	--	--	3	--	--	--	3	--	--	28	--	36	--	30	--

Table 11.--Range and average volume loss and change in lumber grade by species

Species	Rough green volume	Volume loss: Between mills	Volume loss: All mills	Grade change (all mills): Upgraded	Unchanged	Degraded
	Bd. ft.	Percent				
asswood	23,634	3-7	4	2	86	8
ellow birch	53,620	3-4	4	3	84	9
ed maple	52,604	2-4	3	4	86	7
ugar maple	68,951	2-3	3	2	82	13
lack oak	68,231	2-5	3	2	86	9
hestnut oak	111,701	3-6	4	5	80	11
orthern red oak	178,006	2-5	4	6	76	14
carlet oak	49,848	3	3	5	81	11
hite oak	84,900	3-6	5	4	79	12
ellow-poplar	89,945	2-5	4	5	81	10
	781,440					

EPICORMIC BRANCHING:

Seasonal Change, Influence of Fertilization, and Frequency of Occurrence in Uncut Stands

by L. R. Auchmoody

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EPICORMIC BRANCHES—the sprouts that form on the trunk of a tree—may degrade the quality of the logs that can be obtained from the tree.

Patterns of epicormic branches that develop on trees left in and around a cut stand have been reasonably well defined. However, very little is known about epicormic branching in uncut stands that have been fertilized.

Experiments done in cut stands have shown that the degree of branching is a function of height on the bole and of dominance class *(3, 5, 6, 7, 8, 9);* that certain species are more prone to branching than others *(5, 6, 7);* that formation of epicormic branches may be influenced by genetic composition *(1, 9);* and that tree size, within a dominance class, bears little relation to the number of epicormic branches that may develop after release *(2, 9).*

Kormanik and Brown *(4)* found that suppressed buds of young sweetgum *(Liquidambar styraciflua* L.) were stimulated by heavy fertilization to form epicormic branches, but information about other species and age classes is lacking. Because ultimate evaluation of forest fertilization practices must include changes in log quality as well as changes in growth rate, there is a need for more knowledge about this.

In a study made in West Virginia, we learned: (1) that numbers of small epicormic shoots in uncut stands vary within the growing season; (2) that fertilization with N, P, and K does not stimulate epicormic branches to form; and (3) that certain branching relationships established for cut stands also hold for uncut stands.

METHODS

Data for this study were collected from 78 red oak *(Quercus rubra* L.) and 199 yellow-poplar *(Liriodendron tulipifera* L.) trees located in 65 forest-fertilization test plots spread throughout the northern mountain section of West Virginia. Study trees varied from 10 to 20 inches in diameter at breast height and were estimated to range in age from 50 to 80 years. All belonged to either dominant or codominant crown classes and had developed under even-age stand conditions (fig. 1). For either species, only minor changes in site quality existed between the different test locations.

Fertilization treatments were arranged in randomized complete blocks. There were four blocks for red oak and seven for yellow-poplar, each located on independent test sites. Treatments included: (1) the untreated control, (2) P at 87 pounds per acre (lb./acre), (3) N at 300 lb./acre, (4) N and P at 300 and 87 lb./acre, respectively, and (5) N, P, and K at 300, 87 and 83 lb./acre, respectively. Urea, triple superphosphate, and muriate

Figure 1.—An even-aged upland hardwood stand, showing stems similar to those used for the study.

of potash fertilizers were used as nutrient sources. Because the triple superphosphate contained 18 percent Ca, all plots treated with P also received 78 lb./acre of Ca.

For each sample tree, the number of epicormic branches on the first and second logs was recorded separately. Three separate counts were made. The initial measurements were made in the spring immediately after fertilization as soon as the trees had fully leafed out. The second count was made in the same year in autumn, prior to leaf fall, to determine whether or not significant changes in numbers had occurred within the season. The third set of measurements were made during the following spring (second growing season after fertilization) and were used with the first-year data to determine whether or not fertilization had stimulated epicormic branches to form. General observations of growth and vigor of the epicormic branches were made by climbing 45 sample trees for each treatment late in the summer in which fertilizers were applied.

An epicormic branch was defined as any live shoot or bud cluster with leaves occurring upon the bole. Branches varied from young succulent shoots to several years old.

RESULTS

Seasonal Change

Many epicormic branches died during the growing season. For red oak, branch numbers declined 75 percent and 18 percent on the first and second logs, respectively (fig. 2). For yellow-poplar, numbers declined by 25 percent and 9 percent on the first and second logs—far less than for red oak. For both species, the actual numbers of shoots still alive in the fall were significantly related ($P < .001$) to the initial number present at the beginning of the season.

Field observations indicated that mortality was almost entirely limited to short current-season shoots, which had developed from clusters of dormant or adventitious buds on the bole. Frequency of occurrence and mortality of these short shoots was greater on the first log than on the second for both species and was greater for red oak than for yellow-poplar.

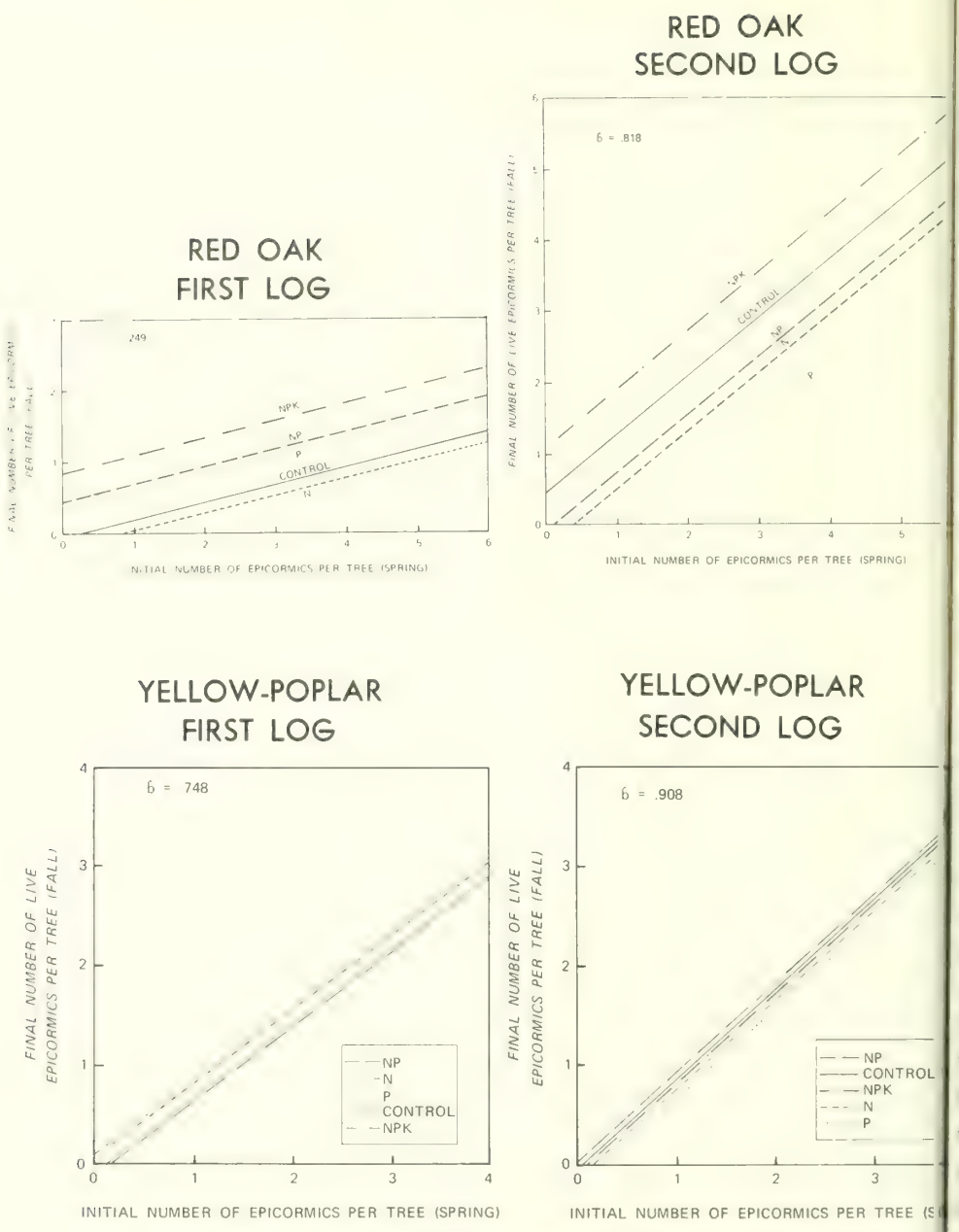

Figure 2.—Relationship between initial branch numbers in the spring and final branch numbers in the fall as affected by fertilizer treatments.

These findings suggest that repeated measurements of epicormic branch numbers in future studies should be limited to definite time intervals to achieve valid comparisons.

Effects of Fertilization

Fertilization did not significantly (5 percent level) stimulate epicormic branches to form on either the first or second logs of red oak or yellow-poplar in the first season after fertilizers were applied. However, there was a tendency for greater branch numbers to occur on the first log of red oak for certain fertilization treatments (particularly NPK) than on control trees (fig. 2); but the increase was not large enough to be declared statistically significant and did not occur in the second season. Nevertheless, it is interesting that more epicormic branches were observed for treatments containing P and Ca than in the non-fertilized control or N alone treatments. On the second log of red oak and on both logs of yellow-poplar, however, fertilizers definitely did not affect branch numbers (note levels, fig. 2).

Second-year results, like those for the first year, showed that epicormic branch numbers were not significantly (5 percent level) increased by any of the fertilization treatments.

Although fertilizers had little effect on stimulating dormant buds to form new branches, in both species, all treatments that included N had a strong tendency to increase vigor and growth of existing epicormic branches located above the first two logs (fig. 3). Simultaneous addition of P and K with N did not produce noticeable differences in either leaf size or growth of these branches over the increase resulting from N alone.

Increased branch growth resulting from fertilization was a function of height on the bole. General observations indicated that growth of existing epicormic branches on the first and second logs were not stimulated nearly as much as those occurring closer to the base of the live crown (indicating a possible interaction with light). Because N increased vigor and growth of these higher branches, there is a possibility that fertilization treatments that contain N may prolong their existence.

Figure 3.—Effect of nitrogen fertilization on growth of epicormic branches.

Branching Frequency

Branching patterns in uncut stands generally paralleled those reported after cutting, except that the degree of branching was substantially less than in cut stands. The data (table 1) illustrate that: (1) red oak was more prone to branching than yellow-poplar (6½ times more epicormic branches occurred on the first

Table 1.—*Means and standard deviations for epicormic branch numbers in uncut stands by species and log position*

Species	First log		Second log	
	Mean	Standard deviation	Mean	Standard deviation
Red oak	1.76	3.11	3.68	4.38
Yellow-poplar	0.27	0.70	1.07	2.18

log, and 3½ times more occurred on the second log of red oak as compared to yellow-poplar); (2) branch numbers were more variable on red oak than on yellow-poplar and showed wider variability on the second log than on the first; and (3) bole sprouting was greater on the second log than on the first, for both species.

Relationships between tree diameter and branch numbers on the bole at the beginning and close of the growing season were examined separately by species for each log. There was no apparent correlation between tree diameter and the number of epicormic branches present in the spring or fall of the year on either the first or second logs for either species.

Although there are many other possible factors besides tree size that might influence branch numbers, these variables could not be identified in the field by comparing individual trees having sprouts against individual trees lacking sprouts for identical site conditions. This suggests and supports hypotheses from other studies *(1, 9)* that the tendency of individual trees to form epicormic branches may be under considerable genetic control.

SUMMARY

Study of seasonal changes of epicormic branch numbers, effects of fertilization, and frequency of occurrence in uncut middle-age Appalachian hardwoods showed that:

- Large numbers of current-season epicormic branches died during the growing season. Reduction was greater on the first log than on the second for both species, and it was greater for red oak than for yellow-poplar.
- N, P, or K fertilizers did not stimulate epicormic branches to form during either the first or second season after fertilization, but N did increase vigor and growth of established epicormic branches on high sections of the bole.
- The number of epicormic branches on individual stems in uncut stands was a function of species and log position, but may also be influenced by genetics. Branch numbers were un-

related to tree size within the d.b.h. range of the dominant and codominant trees sampled.

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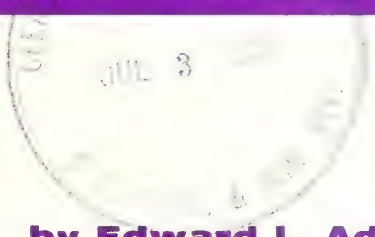
SOLVE:

A Computer Program for Determining the Maximum Value of Hardwood Sawlogs



by Edward L. Adams

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For SOLVE: A Computer Program for Determining the Maximum Value of Hardwood Sawlogs

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SHEET OF

DATA RECORDED BY

COMPONENT NO. 11

Sawing Time Coefficients (2.10)

Species	Log Grade	Coefficients b_o	b_1	b_2
XXX	X	XXX.XXXXX	XXX.XXXXX	XXX.XXXXX
XXX	X	XXX.XXXXX	XXX.XXXXX	XXX.XXXXX
XXX	X	XXX.XXXXX	XXX.XXXXX	XXX.XXXXX
Example:				
RO	1	-0.48686	0.10355	0.00042
RO	2	-0.48686	0.10355	0.00042
RO	3	-0.48686	0.10355	0.00042

Note: In the above example, no differences were found in the sawing time for different log grades. Therefore, the coefficients are the same for all three grades.
To obtain these coefficients, you must record sawing times for your mill by scaling diameter, log length, species, and log grade. Next, separate the data by species and log grade. This provides three sets of data for each species. Finally, run a regression analysis on each data set using the model: Time = $b_o + b_1D + b_2LD^2$, where "D" equals scaling diameter and "L" equals log length.

NE-6500-8 (2-69)

INTRODUCTION

HOW MUCH can a sawmill operator afford to pay for his hardwood sawlogs? The computer program SOLVE, when properly set up for an individual sawmill, can answer this question. SOLVE provides the operator with the maximum values that he can afford to pay for hardwood sawlogs delivered to his mill yard *(Adams 1970)*.

This paper presents the SOLVE system in detail as an aid to users who might want to make changes in the program. These changes might include: (1) adapting the program to a softwood sawmill; (2) consideration of products other than chips, lumber, and sawed timber; and (3) adapting the program to new data and procedures.

The computer program SOLVE is a new approach to the problem of determining hardwood sawlog values. As with any new approach, users becoming familiar with SOLVE will want to make changes in the program. To aid in making these changes, this paper provides a detailed look at both the method used by the program and the program itself.

This paper is not designed to aid an operator in setting up the SOLVE system for his individual sawmill. Because the system is rather complex, an interested operator should contact his State forester for assistance in this task. The State and Private Forestry Division of the USDA Forest Service, working through the State forester, will provide the operator with a "SOLVE Use Packet" and help him in setting up the process for his mill.

THE SOLVE PROGRAM

The SOLVE computer program consists of a main program and two subroutine subprograms (component No. 1, fig. 1). Written in the FORTRAN IV computer language and developed on an IBM 360/65 computer, the program should run on any equivalent computer that uses this language.

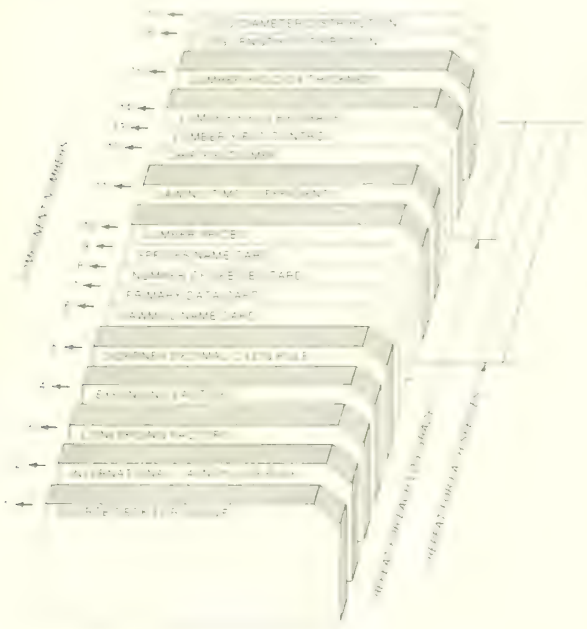

Figure 1.—The SOLVE program deck and input data.

1.1 Main Program

The main program reads the input information, processes that information, and prints the output. However, during the processing of the input information, there are values that must be curved, using a regression technique. The main program calls the subroutine REGR to perform these regressions. For a list of variables, a flow chart, and a program listing of the main program, see Appendix A.

1.2 Subroutine REGR

The subroutine REGR, with the aid of the subroutine REDU, performs a least squares regression analysis *(Husch 1963)*. For a list of variables, a flow chart, and a subprogram listing of REGR, see Appendix B.

1.3 Subroutine REDU

The subroutine REDU reduces a sums of squares and cross products matrix, produced by REGR, to a residual sums of squares. The original matrix and these reductions provide the values needed by REGR to complete the regression analysis. For a list of variables, a flow chart, and a subprogram listing of REDU, see Appendix C.

SOLVE OUTPUT

The SOLVE output consists of separate tables of maximum sawlog values in dollars for the three hardwood factory-log grades within each species. Each table has dollar values per log by 1-inch diameter classes and 2-foot length classes plus weighted average dollar values per MBF for the Doyle, International ¼-inch, and Scribner Decimal C log rules. Table 1 shows an example of these maximum sawlog values for grade 1 northern red oak.

Table 1.—*Representative output for the SOLVE system*

SAWDUST LUMBER COMPANY
MAXIMUM VALUE PER SAWLOG
NORTHERN RED OAK
GRADE 1
DATE 10/03/70
Sawmill Conversion Cost per Minute = $2.50

Diameter (inches)	Length (feet)				
	8	10	12	14	16
8	—	—	—	—	—
9	—	—	—	—	—
10	—	—	—	—	—
11	—	—	—	—	—
12	—	—	—	—	—
13	—	$3.58	$4.96	$6.48	$8.01
14	—	5.01	6.76	8.68	10.61
15	—	6.58	8.73	11.07	13.40
16	—	8.32	10.90	13.69	16.48
17	—	10.21	13.24	16.50	19.78
18	—	12.21	15.73	19.51	23.28
19	—	14.38	18.41	22.72	27.03
20	—	16.66	21.25	26.12	31.00
21	—	19.12	24.26	29.72	35.18
22	—	21.66	27.42	33.48	39.55
23	—	24.46	30.83	37.54	44.30
24	—	27.37	34.41	41.84	49.23
25	—	30.43	38.18	46.31	54.43
26	—	—	—	—	—
27	—	—	—	—	—
28	—	—	—	—	—
29	—	—	—	—	—
30	—	—	—	—	—

$ 85.54 = Value/MBF (International ¼-inch rule)
$103.89 = Value/MBF (Doyle rule)
$ 93.81 = Value/MBF (Scribner Decimal C rule)

SOLVE INPUT

The SOLVE input has 16 parts (components No. 2 through 17, fig. 1). Each component consists of information punched on one or more computer cards. However, in our discussion of the input information for each component, we will not consider the location of this information on these cards. For these instructions, you must go to Appendix D.

2.1 International 1/4-Inch Log Rule

Log volumes from the International ¼-inch log rule are punched onto these cards. These volumes must be calculated by using the International ¼-inch equation and rounding to the nearest board foot. The volumes must represent log sizes ranging from 4 to 40 inches in diameter and 8 to 18 feet in length.

2.2 Converging Factors

The relative log-scale factors punched onto these cards are developed from unrounded volumes from the International ¼-inch log-rule formula by dividing the volumes for 12-foot logs by the volumes for other lengths within each diameter class. For example, a 14-inch log, 12 foot long, has 97.7309 board feet. And a 14-inch log, 10 feet long, has 80.1513 board feet. By dividing 80.1513 into 97.7309, we obtain a factor for 14-inch 10-foot logs of 1.219. These factors are needed for log sizes ranging from 8 to 30 inches in diameter and 7 to 16 feet in length (table 2).

2.3 Expanding Factors

The relative log-scale factors punched on these cards are developed from the unrounded International ¼-inch log rule by dividing the volumes for 12-foot logs into the volumes for 8-, 10-, 12-, 14-, and 16-foot log lengths within each diameter class. Using the log sizes and volumes from the example given in section 2.2, we divide 97.7309 into 80.1513, obtaining a factor for 14-inch, 10-foot logs of 0.820. These factors are needed for log sizes ranging from 8 to 30 inches in diameter and 8, 10, 12, 14, and 16 feet in length (table 3).

2.4 Scribner Decimal C Log Rule

Log volumes from the Scribner Decimal C log rule are punched onto these cards. The volumes must represent log sizes ranging from 4 to 40 inches in diameter and 8 to 18 feet in length.

Table 2.—*Relative log-scale factors for converting log volumes for all lengths to volumes on a 12-foot basis*[1]

Diameter (inches)	Log length (feet)									
	7	8	9	10	11	12	13	14	15	16
8	1.880	1.626	1.406	1.238	1.106	1.000	0.901	0.819	0.751	0.694
9	1.855	1.607	1.395	1.233	1.104	1.000	.904	.824	.758	.701
10	1.837	1.593	1.388	1.229	1.103	1.000	.906	.828	.763	.707
11	1.823	1.583	1.382	1.226	1.101	1.000	.908	.831	.767	.712
12	1.812	1.574	1.377	1.223	1.100	1.000	.909	.834	.770	.715
13	1.803	1.568	1.373	1.221	1.100	1.000	.911	.836	.773	.718
14	1.795	1.562	1.370	1.219	1.099	1.000	.912	.838	.775	.721
15	1.789	1.557	1.367	1.218	1.098	1.000	.913	.839	.777	.723
16	1.784	1.553	1.364	1.217	1.098	1.000	.913	.840	.778	.725
17	1,779	1.550	1.362	1.216	1.097	1.000	.914	.840	.780	.726
18	1.775	1.546	1.361	1.215	1.097	1.000	.914	.842	.781	.728
19	1.771	1.544	1.359	1.214	1.097	1.000	.915	.843	.782	.729
20	1.768	1.541	1.358	1.213	1.096	1.000	.915	.844	.783	.730
21	1.765	1.539	1.356	1.212	1.096	1.000	.916	.845	.784	.731
22	1.763	1.537	1.355	1.212	1.096	1.000	.916	.845	.785	.732
23	1.761	1.535	1.354	1.211	1.096	1.000	.916	.846	.785	.733
24	1.758	1.534	1.353	1.211	1.095	1.000	.917	.846	.786	.734
25	1.757	1.532	1.352	1.210	1.095	1.000	.917	.847	.787	.734
26	1.755	1.531	1.352	1.210	1.095	1.000	.917	.847	.787	.735
27	1.753	1.530	1.351	1.209	1.095	1.000	.918	.848	.788	.736
28	1.752	1.529	1.350	1.209	1.095	1.000	.918	.848	.788	.736
29	1.750	1.528	1.350	1.209	1.094	1.000	.918	.848	.788	.737
30	1.749	1.527	1.349	1.208	1.094	1.000	.918	.849	.789	.737

[1]Factors based on International ¼-inch log rule.

Table 3.—*Relative log-scale factors for expanding log volumes based on 12-foot lengths to 8-, 10-, 14-, and 16-foot lengths*[1]

Diameter (inches)	Log length (feet)				
	8	10	12	14	16
8	0.615	0.808	1.000	1.221	1.442
9	.622	.811	1.000	1.213	1.426
10	.628	.814	1.000	1.207	1.414
11	.632	.816	1.000	1.203	1.405
12	.635	.818	1.000	1.199	1.398
13	.638	.819	1.000	1.196	1.392
14	.640	.820	1.000	1.194	1.388
15	.642	.821	1.000	1.192	1.383
16	.644	.822	1.000	1.190	1.380
17	.645	.823	1.000	1.188	1.377
18	.647	.823	1.000	1.187	1.374
19	.648	.824	1.000	1.186	1.372
20	.649	.824	1.000	1.185	1.370
21	.650	.825	1.000	1.184	1.368
22	.651	.825	1.000	1.183	1.366
23	.651	.826	1.000	1.182	1.365
24	.652	.826	1.000	1.182	1.363
25	.653	.826	1.000	1.181	1.362
26	.653	.827	1.000	1.180	1.361
27	.654	.827	1.000	1.180	1.360
28	.654	.827	1.000	1.179	1.359
29	.655	.827	1.000	1.179	1.358
30	.655	.828	1.000	1.178	1.357

[1]Factors based on International ¼-inch log rule.

2.5 Sawmill Name Card

This card requires the name of the sawmill for which the tables of maximum sawlog values are being developed.

2.6 Primary Data Card

The following information must be punched on the primary data card:

1. The date for which the cost and price information are representative.
2. Sawmill operating cost per minute.
3. Green chip selling price per ton received.
4. Dunnage selling price per MBF.
5. Sawed timber selling price per MBF.
6. Desired profit margin in percent.
7. Necessary risk margin in percent (non-insurable risk).
8. Broker fee or selling cost as a percent.
9. Cash discount in percent.
10. Average productive headsaw time per day.
11. Average number hours the sawmill works per day.

The sawmill operating cost per minute needed for the primary data card must be determined with care. With the exception of the cost of selling the lumber, this cost per minute must include all costs incurred by the mill from the log yard to the lumber loaded for shipment. For a detailed discussion of this cost, see Appendix E.

2.7 Number of Species Card

The number punched on this card reflects the number of different species for which the tables of maximum sawlog values are to be developed.

2.8 Species Name Card

The name punched on this card provides the name of the species represented by the data that follows.

2.9 Lumber Prices

These cards require lumber prices in dollars per MBF by lumber grades for 4/4-, 5/4-, 6/4-, and 8/4-inch lumber (table 4). If lumber prices for grade 3A and grade 3B lumber are not included on these cards, the computer program will use the dunnage price entered on the primary data card (2.6).

A sawed-timber price may be placed on the same card that lists the 8/4-inch lumber prices. However, if the timber price is not placed here, the program will use the sawed-timber price entered on the primary data card (2.6).

Table 4.—*Lumber prices per Mbf., October 3, 1970*[1]

RED OAK — PLAIN

Thickness	FAS	IF	1C	2C	3A	3B[2]
4/4	$245	$235	$135	$85	$75	$60
5/4	250	240	150	85	75	60
6/4	260	250	175	85	75	60
8/4	290	280	200	85	75	60

[1]Hardwood Market Report 48(1): 4-5, 1970.
[2]Dunnage value obtained from local sawmills.

Aside from the 3A, 3B, and timber prices, a lumber price must be entered for each lumber grade for which lumber yields (2.13) are given.

2.10 Coefficients for Sawing-Time Equations

Three sets of coefficients for sawing-time equations must be punched onto these cards: one set of coefficients for each of the three hardwood factory-log grades within a species. New coefficients must be developed for each mill that uses the SOLVE system.

To obtain these coefficients, sawing times in each log grade must be curved by a regression technique, using the following equation form:

$$T = b_o + b_1D + b_2D^2L$$

where:

T = Sawing time by log grade per log.
D = Scaling diameter of log.
L = Length of log.

2.11 Green Chip Yields Per MBF

This card contains chip yields per MBF by diameter class for a given species. Only chips from slabs and edgings must be used in the development of these yields. This input requires yields for logs with diameters from 8 to 25 inches (table 5).

Because chip yields by species are not available, the yields shown in table 5 are for mixed hardwoods. Used in SOLVE, these yields should provide satisfactory results for all species until chip yields by species can be obtained.

Table 5.—*Residue from debarked slabs and edgings of mixed hardwoods*[1]

Log diameter (inches)	Slabs-edgings (tons/MBF)
8	2.30
9	1.99
10	1.73
11	1.47
12	1.26
13	1.10
14	.99
15	.89
16	.84
17	.79
18	.73
19	.68
20	.63
21	.58
22	.52
23	.52
24	.52
25	.52

[1]Keppler, William E., Jr., and William E. Duggan. The mechanized portable sawmill—a key to higher productivity. N. C. Agr. Ext. Serv. Misc. Ext. Pub. 41, 28 pp. Raleigh, 1968.

2.12 Lumber Yield Control

The following information must be punched onto this card:

1. Minimum diameter class for which lumber yield data (2.13) are given.
2. Maximum diameter class for which lumber-yield data (2.13) are given.
3. Degrade factor.

SOLVE uses this degrade factor to adjust lumber values for the degrade that occurs with the air-drying of lumber. If the lumber yields (2.13) are based on air-dry lumber or if degrade has already been accounted for, this factor is 1.00. However, if degrade has not been accounted for, the user must subtract a loss in percent of air-dry lumber value (as a decimal) from 1.00 to obtain a degrade factor.

Recommended losses and resulting degrade factors are *(Cuppett 1965):*

Species	*Percent loss*	*Degrade factor*
White oak and red oak	2.0	0.98
Yellow-poplar, basswood, cucumber	1.0	0.99
Maple and beech	3.0	0.97

2.13 Lumber Yield by Log Grade

These cards must contain lumber yields by diameter class for a given species and grade of sawlogs (table 6). Each card represents a

Table 6.—*Dry lumber grade yields*[1]
NORTHERN RED OAK (Grade 1)

N	Diameter	Gross Int. ¼ volume	Lumber tally	FAS	1F	1C	2C	3A	3B
				Percent					
12	13	1035	1091	22.5	15.0	24.9	19.2	17.1	1.2
17	14	1945	2040	25.2	13.0	32.1	16.3	11.1	2.2
18	15	2510	2551	25.5	14.9	27.5	21.2	8.7	2.1
22	16	3320	3308	28.5	14.1	27.0	17.1	11.7	1.6
22	17	4190	4401	36.8	13.5	26.4	15.6	6.1	1.7
14	18	2710	2888	40.1	16.0	21.4	13.5	6.9	2.1
16	19	3705	3892	43.3	14.3	22.2	13.5	5.5	1.2
8	20	1925	1918	40.9	14.0	27.1	9.7	7.2	1.0
4	21	1075	1072	39.8	16.8	22.4	13.9	7.0	.0
5	22	1480	1520	55.9	11.2	15.6	9.3	7.4	.7
2	23	725	827	68.1	8.0	12.4	10.5	1.1	.0
1	24	310	258	40.7	5.8	22.5	15.1	10.1	5.8
1	25	340	375	44.0	6.1	21.1	16.0	4.3	8.5

[1]Information obtained from USDA Forest Service Research Note NE-65.

diameter class and has the following information punched onto it:

1. Number of sample logs used to produce the lumber yields in this diameter class.
2. Diameter class.
3. Total gross International ¼-inch log scale from the sample logs in this diameter class.
4. Total dry-lumber tally from the sample logs in this diameter class.
5. Percent of dry-lumber tally by lumber grade from the sample logs in this diameter class.

This lumber-yield information can be found in three USDA Forest Service publications: (1) northern red oak yields in Research Note NE-65 *(Schroeder and Hanks 1967);* (2) black cherry yields in Research Note CS-44 *(Hanks 1965);* and (3) lumber yields for several other species in Research Paper FPL-63 *(Vaughn and others 1966).*

2.13a Lumber Grade Adjustment

Each of the above publications shows lumber yields for a Select lumber grade. Because of the practice in the Appalachian hardwoods of using a 1 Face lumber grade instead of this Select grade, adjustments must be made in the lumber yields from all three yield publications before using them.

In making these adjustments, we have two situations. In the first situation, lumber-yield data show yields for both 1 Face and Select lumber grades. Here the Selects are added to the 1 Common yields. In this case the Selects, as described in the lumber rule (National Hardwood Lumber Association RULES FOR THE MEASUREMENT AND INSPECTION OF HARDWOOD AND CYPRESS LUMBER, 116 pp., 1967), make up only a small percent of the total volume. In the second situation, lumber-yield data show yields for the Select lumber grade but not for the 1 Face grade. Here the Selects are called 1 Face. As described in the lumber rule, only a small percent of the Selects would not make the 1 Face grade in this case. In both of these situations, this shift of a small percentage of the total yield should produce an insignificant change in the final log values.

2.14 Lumber Yields by Thickness

These cards must contain the percent yields of 4/4-, 5/4-, 6/4-, and 8/4-inch lumber for each lumber grade by diameter class (table 7). The lumber yields by thickness must be developed from the same basic data used in producing the lumber yields by grade (2.13).

If the user wishes to apply the lumber-grade yields from the three publications mentioned in section 2.13, the corresponding lumber yields by thickness are available through the Log and Tree Grade Project of the USDA Forest Service at Columbus, Ohio. Should the user decide to apply the thickness yields developed by the Columbus Unit, adjustments must be made to handle thicknesses not covered by the SOLVE program.

First add the lumber yield percentages for thicknesses less than 4/4-inch to the 4/4-inch

Table 7.—*Percent of dry lumber yield by thickness by diameter class*[1]
NORTHERN RED OAK (Grade 1)

Diameter	Thickness	FAS	1F	1C	2C	3A	3B	Timbers
		Percent						
14	4/4	83.7	93.0	90.8	97.6	100.0	100.0	—
	5/4	14.4	7.0	7.3	2.4	—	—	—
	6/4	1.9	—	1.9	—	—	—	—
	8/4	—	—	—	—	—	—	100.0

[1]This type of information was obtained from the Columbus, Ohio, Laboratory of the Northeastern Forest Experiment Station.

yield percentages. Then add lumber-yield percentages for thicknesses greater than 8/4-inch to the 8/4-inch yield percentages (in both cases, these adjustments will have little effect on the final sawlog values). These manipulations give the percent yields by thickness required by the SOLVE system.

2.15 Log Length Distribution

This card contains the frequency distribution in percent of logs found in the different length classes for a given log grade and species (table 8). The percentages are developed by sampling a population of sawlog lengths and dividing the total number of sample logs into the number of sample logs found in each length class.

Table 8.—*Log size distributions for grade 1 northern red oak*[1]

Distribution by length		*Distribution by diameter*	
Length	Percent	Diameter	Percent
8	—	13	16
10	11	14	10
12	33	15	14
14	26	16	12
16	30	17	9
—	—	18	12
—	—	19	11
—	—	20	5
—	—	21	3
—	—	22	1
—	—	23	1
—	—	24	1
—	—	25	1
—	—	26	2
—	—	27	1
—	—	28	1

[1]Goho, Curtis D., and Paul S. Wysor. Characteristics of factory-grade hardwood logs delivered to Appalachian sawmills. USDA Forest Serv., Res. Paper NE-166, 17 pp., illus. NE Forest Exp. Sta., Upper Darby, Pa. 1970.

2.16 Log Diameter Distribution

This card contains the frequency distribution in percent of logs found in the different diameter classes for a given log grade and species (table 8). The percentages are developed by sampling a population of sawlog diameters and dividing the total number of sample logs into the number of sample logs found in each diameter class. The same logs should be used for this sample that were used to obtain the log-length frequency distribution (2.15).

SOLVE METHOD

To simplify the discussion of the SOLVE method, we will consider the production of maximum sawlog values for only grade 1 northern red oak (table 1). SOLVE uses the same method for each species and log grade, requiring only a change in data. This method employes the following sequential steps:

1. Calculation of lumber value per log. The term *per log* refers to logs by 1-inch diameter classes and 2-foot length classes.
2. Calculation of chip value per log.
3. Calculation of sawmill conversion cost per log.
4. Calculation of maximum sawlog value per log.
5. Calculation of maximum sawlog values per MBF.

3.1 Calculation of Lumber Value per Log

Available lumber-yield information does not have the yields broken down by log length. Therefore lumber yield per log cannot be computed directly. SOLVE overcomes this difficulty by repeating the following procedure for each diameter class.

Step 1. Average gross International ¼-inch volume is obtained by dividing the gross International ¼-inch volume (table 6) by the number of sample logs (table 6).

Step 2. Average log length is obtained by finding the length in the International ¼-inch log rule (rounded to nearest board foot) that has a volume nearest the average volume from Step 1.

Step 3. Average dry-lumber tally is obtained by dividing the dry-lumber tally (table 6) by the number of sample logs (table 6).

Step 4. Average lumber tally (12-foot basis) is obtained by applying a relative log-scale factor (table 2) to the lumber-tally yield from Step 3. For example, the 14-inch diameter class in table 6 has an average lumber tally of 120 board feet and an average log length from Step 2 of 14 feet. A 14-inch 14-foot log has a relative log-scale factor of 0.838 (table 2). This factor multiplied by the lumber tally (14-foot basis) of 120 board feet produces a lumber tally (12-foot basis) of 101 board feet for the 14-inch diameter class.

Step 5. At this point, with Steps 1 through 4 completed for all diameter classes, SOLVE performs a regression analysis on the values from Step 4 to produce curved average lumber-tally volumes (12-foot basis).

Step 6. Board-foot yields (12-foot basis) by lumber grade are obtained by applying the lumber-yield percentages (table 6) to the curved volume from Step 5.

Step 7. Weighted lumber price per board foot for each lumber grade is obtained by applying the percent lumber yield by thickness (table 7) to the lumber price by thickness (table 4) and dividing by 1000.0. This procedure is repeated for each lumber grade.

Step 8. Average lumber value (12-foot basis) is obtained by summing the products of lumber yields (Step 6) multiplied by the weighted lumber prices (Step 7).

Step 9. At this point with Steps 1 through 8 completed for all diameter classes, SOLVE performs a regression analysis on the lumber values from Step 8, producing curved lumber values (12-foot basis).

Step 10. Lumber values for 8-, 10-, 12-, 14-, and 16-foot log lengths (table 9) are obtained by applying the relative log-scale factors (table 3) to the curved lumber values from Step 9. Any adjustment in lumber value to allow for degrade during drying is made in this step.

Table 9.—*Lumber values per log*

Scaling diameter (inches)	Log length (feet)				
	8	10	12	14	16
13	$ 8.02	$10.29	$12.57	$15.03	$17.50
14	10.16	13.02	15.88	18.96	22.04
15	12.49	15.97	19.45	23.18	26.90
16	15.01	19.16	23.31	27.74	32.17
17	17.69	22.57	27.43	32.59	37.77
18	20.59	26.19	31.82	37.77	43.72
19	23.65	30.07	36.49	43.28	50.06
20	26.89	34.14	41.43	49.09	56.76
21	30.32	38.48	46.64	55.22	63.80
22	33.94	43.01	52.13	61.67	71.21
23	37.68	47.81	57.88	68.41	79.01
24	41.67	52.79	63.91	75.54	87.11
25	45.85	57.99	70.21	82.92	95.63

3.2 Calculation of Green Chip Value per Log

Chip yield in tons per MBF changes as log diameter increases. To allow for this, SOLVE uses chip yield by diameter class (table 5) to compute chip value per log. The following procedure for determining these chip values must be repeated for each diameter class.

Step 1. Lumber tally yields for 8-, 10-, 12-, 14-, and 16-foot log lengths are obtained by multiplying the lumber-tally yield (12-foot basis) from Step 5 (3.1) by relative log-scale factors from table 3.

Step 2. Chip value per board foot is obtained by multiplying the chip price per ton (2.6) by the chip yield (table 5) and dividing by 1000.

Step 3. Chip value per log (table 10) is obtained by multiplying chip value per board foot from Step 2 by the lumber-tally yields from Step 1.

Table 10.—*Green chip value per log*

Scaling diameter (inches)	Log length (feet)				
	8	10	12	14	16
13	—	$0.51	$0.62	$0.74	$0.87
14	—	.54	.65	.78	.91
15	—	.56	.68	.81	.94
16	—	.60	.74	.87	1.01
17	—	.65	.79	.93	1.08
18	—	.68	.82	.98	1.13
19	—	.71	.86	1.02	1.18
20	—	.73	.89	1.05	1.22
21	—	.75	.91	1.08	1.24
22	—	.74	.90	1.07	1.23
23	—	.82	.99	1.17	1.35
24	—	.90	1.08	1.28	1.48
25	—	.98	1.18	1.40	1.61

3.3 Calculation of Sawmill Conversion Cost per Log

Assuming that the headsaw will be functioning at all times during normal operation, we picked headsaw operating time as a basis for assigning the proportionate share of the sawmill operating cost to each log. We will refer to this cost as the sawmill conversion cost. The following steps describe how SOLVE computes these costs:

Step 1. Sawing time per log is obtained from a regression equation (2.10).

Step 2. Sawing times are increased by a factor to allow for normal downtime. The factor is developed by dividing the average productive headsaw time into the average number of hours the sawmill works per day.

Step 3. Sawmill conversion cost per log (table 11) is obtained by multiplying the adjusted sawing times in Step 2 by the sawmill conversion cost per minute (2.6).

Table 11.—*Sawmill conversion cost per log*

Scaling diameter (inches)	Log length (feet)				
	8	10	12	14	16
13	—	$4.48	$4.89	$5.29	$5.70
14	—	5.10	5.57	6.04	6.51
15	—	5.75	6.29	6.83	7.37
16	—	6.41	7.03	7.64	8.26
17	—	7.11	7.80	8.49	9.19
18	—	7.82	8.60	9.38	10.16
19	—	8.56	9.43	10.30	11.16
20	—	9.33	10.29	11.25	12.21
21	—	10.11	11.17	12.23	13.29
22	—	10.93	12.09	13.25	14.41
23	—	11.76	13.03	14.30	15.57
24	—	12.62	14.00	15.39	16.77
25	—	13.51	15.01	16.51	18.01

3.4 Calculation of Maximum Sawlog Value per Log

At this point, SOLVE has computed lumber value, chip value, and sawmill conversion cost per log. These are the necessary values for determining the maximum sawlog values per log in table 1. However, the final sawlog values must reflect deductions for profit, risk, lumber selling cost, and cash discount. The following steps show the procedure used in making these deductions.

Step 1. Net lumber value per log is obtained by subtracting selling cost (2.6) and cash discount (2.6) from the gross lumber value per log (table 9).

Step 2. Net product value per log is obtained by adding net lumber value per log in Step 1 to chip value per log (table 10) and from this total subtracting both profit and risk.

Step 3. Maximum sawlog value per log (table 1) is obtained by subtracting sawmill conversion cost per log (table 11) from net product value per log (Step 2).

3.5 Calculation of Average Maximum Sawlog Values per MBF

SOLVE produces weighted average sawlog values per MBF for the International ¼-inch, Doyle, and Scribner Decimal C log rules (table 1). The following steps describe the procedure used.

Step 1. The dollar values per log in table 1 are changed to dollar values per MBF for the three log rules mentioned above.

Step 2. Weighted log values per MBF for each diameter class are obtained by multiplying the dollar values per MBF (Step 1) in each length class by the frequency distribution of log lengths (table 8), summing the resulting values and dividing by 100. This is repeated for each log rule.

Step 3. Weighted sawlog values per MBF for the three log rules are obtained by multiplying the weighted dollar

values from Step 2 by the frequency distribution of log diameters (table 8), summing the resulting values, and dividing by the sum of diameter distribution percentages. These percentages will not necessarily add to 100 because the range of diameters covered by the diameter frequency distribution will not always fit the range of diameters covered in the basic lumber yield data.

DISCUSSION

This paper contains the information necessary for understanding and making changes in the SOLVE computer program. Once a sawmill operator knows what changes he wishes to make, he turns this paper and the required changes over to a computer programmer. The programmer should have little difficulty in making such changes as (1) adapting SOLVE to a pine sawmill, (2) adapting the program to consider new products, and (3) adapting the program to new data and new procedures.

I must emphasize that this paper is not designed to aid an operator in setting up the SOLVE system for his individual sawmill. For this, a potential user should contact his State forester. Working through the State forester, the State and Private Forestry Division of the USDA Forest Service will provide a "SOLVE Use Packet" and help in the data-collecting phase of the setup.

State and Private Forestry can also eliminate much of the work of punching the program and input information onto cards. They can provide the entire SOLVE deck, consisting of the computer program and all components of the input information for 10 hardwood species (northern red oak, black oak, upland red oak group, upland white oak group, chestnut oak, hard maple, yellow-poplar, basswood, beech, and black cherry). Users will then only have to change those inputs that do not fit their milling situations.

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■

APPENDIX A

List of Variables for Main Program

A(I,J) = The following lumber-yield information by diameter class.
A(I,1)—Number of sample logs.
A(I,2)—Diameter class.
A(I,3)—Total gross International ¼-inch volume.
A(I,4)—Total lumber tally volume.
A(I,5) through A(I,15)—Lumber yields in percent by grade.

AA,AB,AC = Coefficients for the average lumber-value equation that provides dollar values by diameter class for 12-foot logs.
Model: $Y = b_o + b_1D + b_2D^2$
where: Y=dollar value.
D=log scaling diameter.

AAAA(I) = Net product value per log.

AL = Sawlog length.

ALTH = Sawlog length.

AV = Curved average lumber value per log adjusted for degrade due to lumber drying.

AVV = Curved average lumber value per log by diameter class for 12-foot logs.

AVOL = Average gross International ¼-inch volume by diameter class.

B(I,J) = Percent lumber yield by grade and thickness.

BA,BB,BC = Coefficients for the average lumber-tally volume equation that provides volumes by diameter class for 12-foot logs.
Model: $Y = b_o + b_1D + b_2D^2$
where: Y=lumber-tally yield.
D=log-scaling class.

BRK = Broker or selling cost as a percent of lumber value.

BVOL = Value from International ¼-inch volume table.

C(I,J) = Lumber values by species, grade, and thickness.

CCCC(I) = Dollar value of chip residue per log by diameter and length classes.

CHP(I) = Residue chip yields in tons per MBF by diameter classes.

CO(I) = Coefficients for sawing time equations. The model used was:
Time $= b_o + b_1D + b_2LD^2$
where: D=scaling diameter of log.
L=log length.

COST = Sawmill operating cost per minute.

CPPR = Chip price per ton.

CVOL = Value from International ¼-inch volume table.

D(I,J) = Total weighted lumber value per board foot by lumber grade and diameter class.

DEG = Percent to allow for degrade if the lumber yield inputs are based on green lumber scale.

DI(I) = Diameter class.

DIAM = Sawlog scaling diameter.

DIS = Cash discount as a percent of the lumber value.

DOYL = Doyle volume.

DUN = Dunnage price per MBF.

E(I,J) = Net sawlog value per log by diameter, length, and grade.

FACI(I,J) = Relative log-scale factors based on International ¼-inch rule. These factors are used to convert the average lumber-tally volumes for different average log lengths to a 12-foot basis.

FACO(I,J) = Relative log-scale factors based on the International ¼-inch rule. These factors are used to expand both lumber-tally volumes and dollar values for 12-foot logs to relative volumes and values for 8-, 10-, 14-, and 16-foot log lengths.

FR(I) = Number of sample logs per diameter class in lumber-yield input data.

H = Average number hours the sawmill works per day.

IDAY = Day of the date represented by the lumber price inputs.

II = Lower diameter limit for which yields are given in the lumber yield inputs.

ISP = Index for the number of species for which sawlog value tables are to be developed.

IX = Average log lengths by diameter class obtained by going to the International ¼-inch volume table with the different diameter classes and their respective average gross International ¼-inch volumes.

IYEAR = Year of the date represented by the lumber-price inputs.

JJ = Upper diameter limit for which yields are given in the lumber-yield inputs.

K(I,J) = International ¼-inch volume table.

KS(I,J) = Scribner volume table.

LGTH(I) = Average log lengths by diameter class obtained by going to the International ¼-inch volume table with the different diameter classes and their respective average gross International ¼-inch volumes.

M = Calculated subscript for locating the diameter row of both the International ¼-inch and Scribner volume tables.

MILL(I) = Sawmill name.

MNTH = Month of the date represented by the lumber-price inputs.

N = Calculated subscript for locating the length column of both the International ¼-inch and Scribner volume tables.

NO = Number of species for which sawlog value tables are to be developed.

PER1(I) = Sawlog length-frequency distributions (%).

PER2(I) = Sawlog diameter-frequency distribution (%).

PERR = Total sawlog diameter-frequency distribution in percent (cumulative).

PH = Average productive headsaw time per day.

PRF = Required profit percent.

REGR(A,B,C) X,Y,Z) = Subroutine for developing regression equations.

RSK = Require risk percent.

SPEC(I) = Species name.

TIME(I) = Regressed sawing times.

TMBR = Timbers price per MBF.

TT(I) = The curved lumber value by diameter classes for 12-foot logs, less broker cost and cash discount, expanded to 8-, 10-, 14-, and 16-foot lengths.

TTCC(I) = Sawlog lumber and chip conversion cost by diameter and length classes.

TV(I) = Uncurved average lumber value by diameter class for 12-foot log lengths.

TVA(I) = Lumber value less broker cost and cash discount plus chip value. This value is on a per-log basis.

TVAL = Curved average lumber value per log by diameter class for 12-foot logs less broker cost and cash discount.

TWTVA = Total weighted lumber value per MBF by lumber grade and diameter class (cumulative).

VA(I) = Weighted average sawlog value per MBF (International ¼-inch).

VA1 = Proportionate average value per MBF (International ¼-inch), by length class for each diameter class.

VA2 = Total average value per MBF (International ¼-inch) by length class for each diameter class (cumulative).

VA3 = This value would be the proportionate average value per MBF (International ¼-inch) by diameter class if divided by the total sawlog diameter-frequency distribution.

VA4 = This value becomes the total average value per MBF (International ¼-inch) when divided by the total sawlog diameter-frequency distribution (cumulative).

VAL(I,J) = Uncurved lumber value by lumber grade and diameter class for 12-foot log lengths.

VALU = Uncurved lumber value by diameter class for 12-foot log lengths (cumulative).

VB(I) = Weighted average sawlog value per MBF (Doyle).

VB1 = Proportionate average value per MBF (Doyle) by length class for each diameter class.

VB2 = Total average value per MBF (Doyle) by length class for each diameter class (cumulative).

VB3 = This value would be the proportionate average value per MBF (Doyle) by diameter class if divided by the total sawlog diameter-frequency distribution.

VB4 = This value becomes the total average value per MBF (Doyle) when divided by the total sawlog diameter frequency distribution (cumulative).

VC(I) = Weighted average sawlog value per MBF (Scribner).

VC1 = Proportionate average value per MBF (Scribner) by length class for each diameter class.

VC2 = Total average value per MBF (Scribner) by length class for each diameter class (cumulative).

VC3 = This value would be the proportionate average value per MBF (Doyle) by diameter class if divided by the total sawlog diameter-frequency distribution.

VC4 = This value becomes the total average value per MBF (Doyle) when divided by the total sawlog diameter-frequency distribution (cumulative).

VOL = Gross International ¼-inch volume.

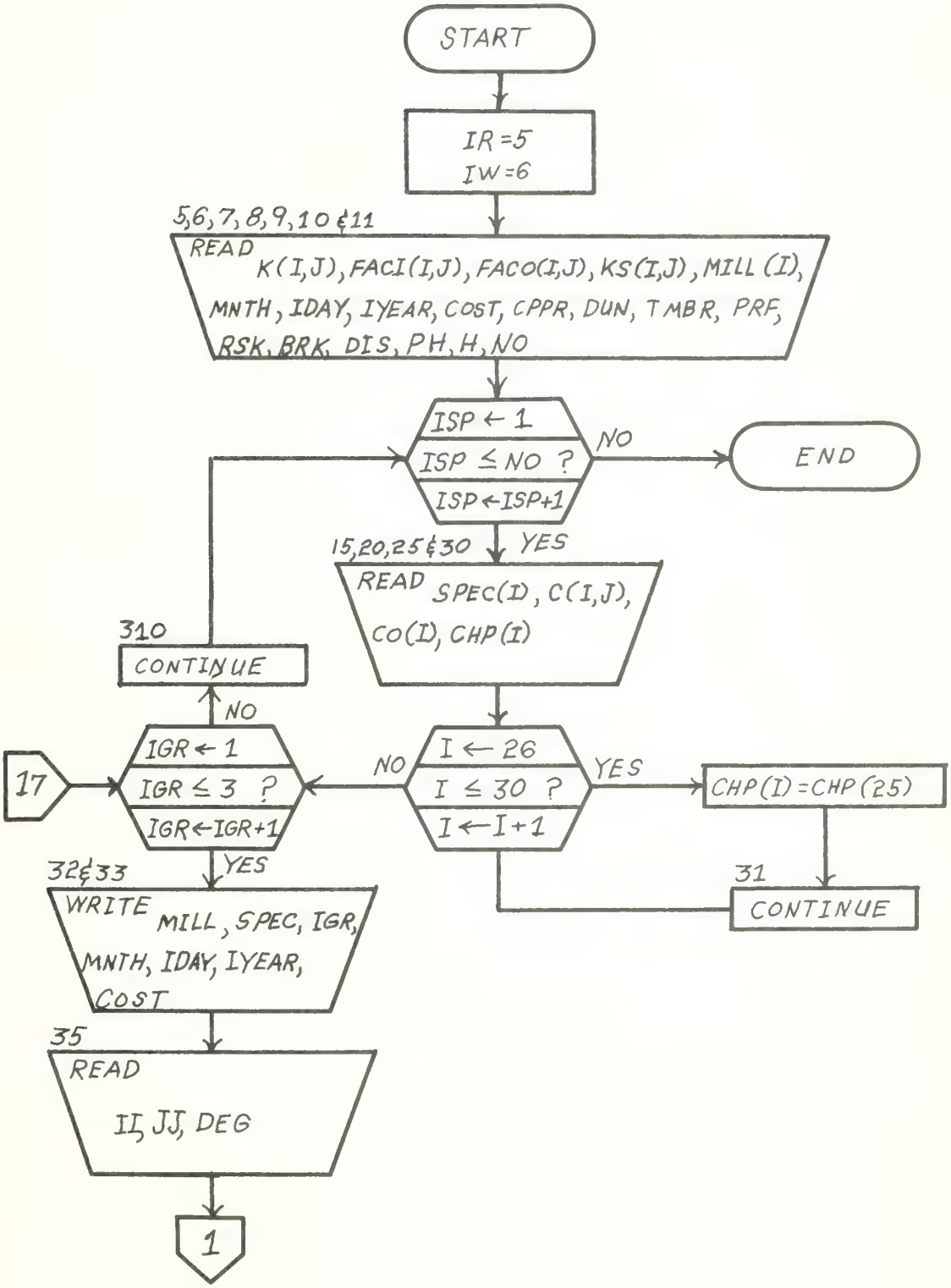
VOLS = Scribner volume.

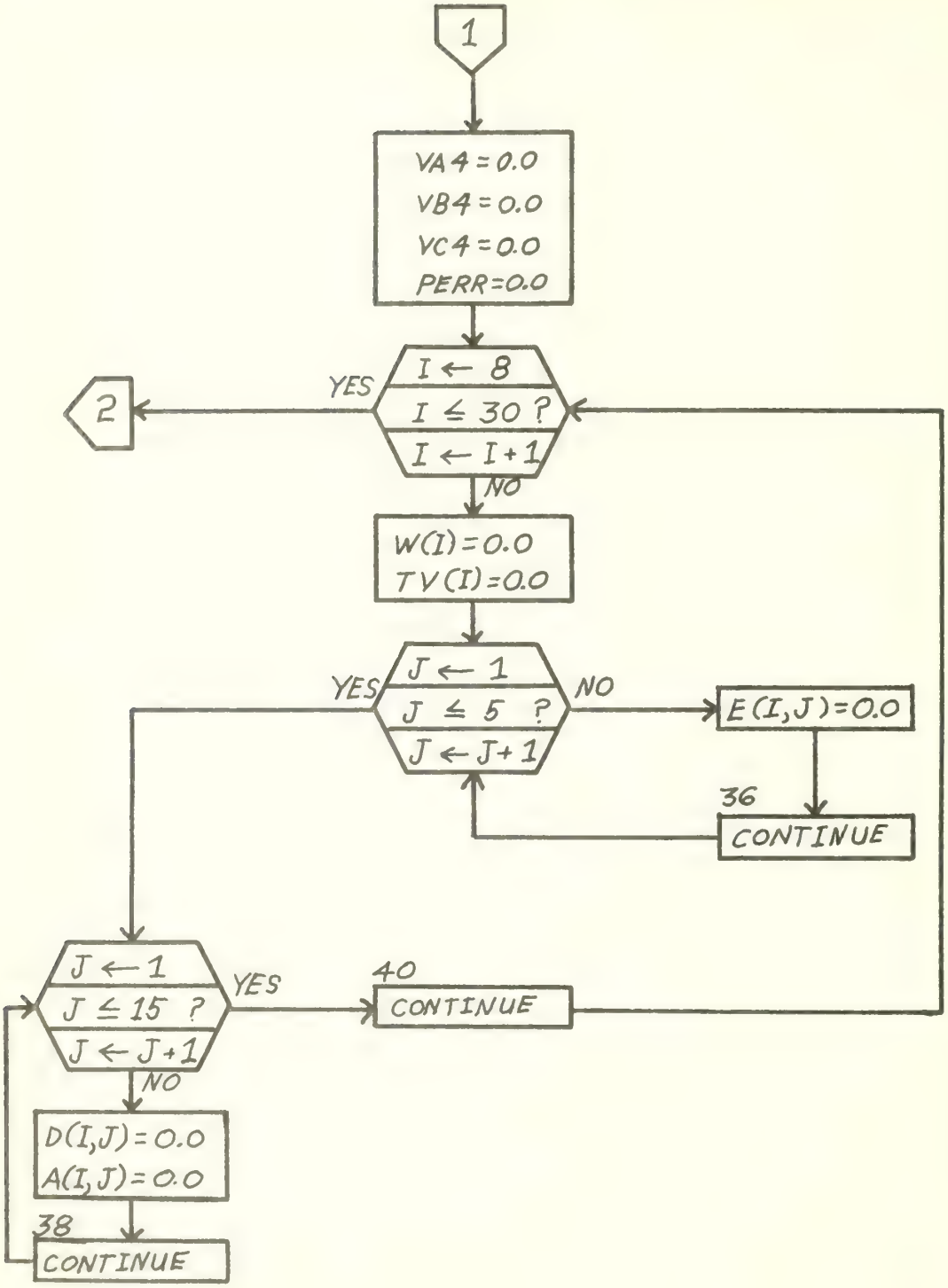
W(I) = Curved average lumber tally by diameter class for 12-foot log lengths.

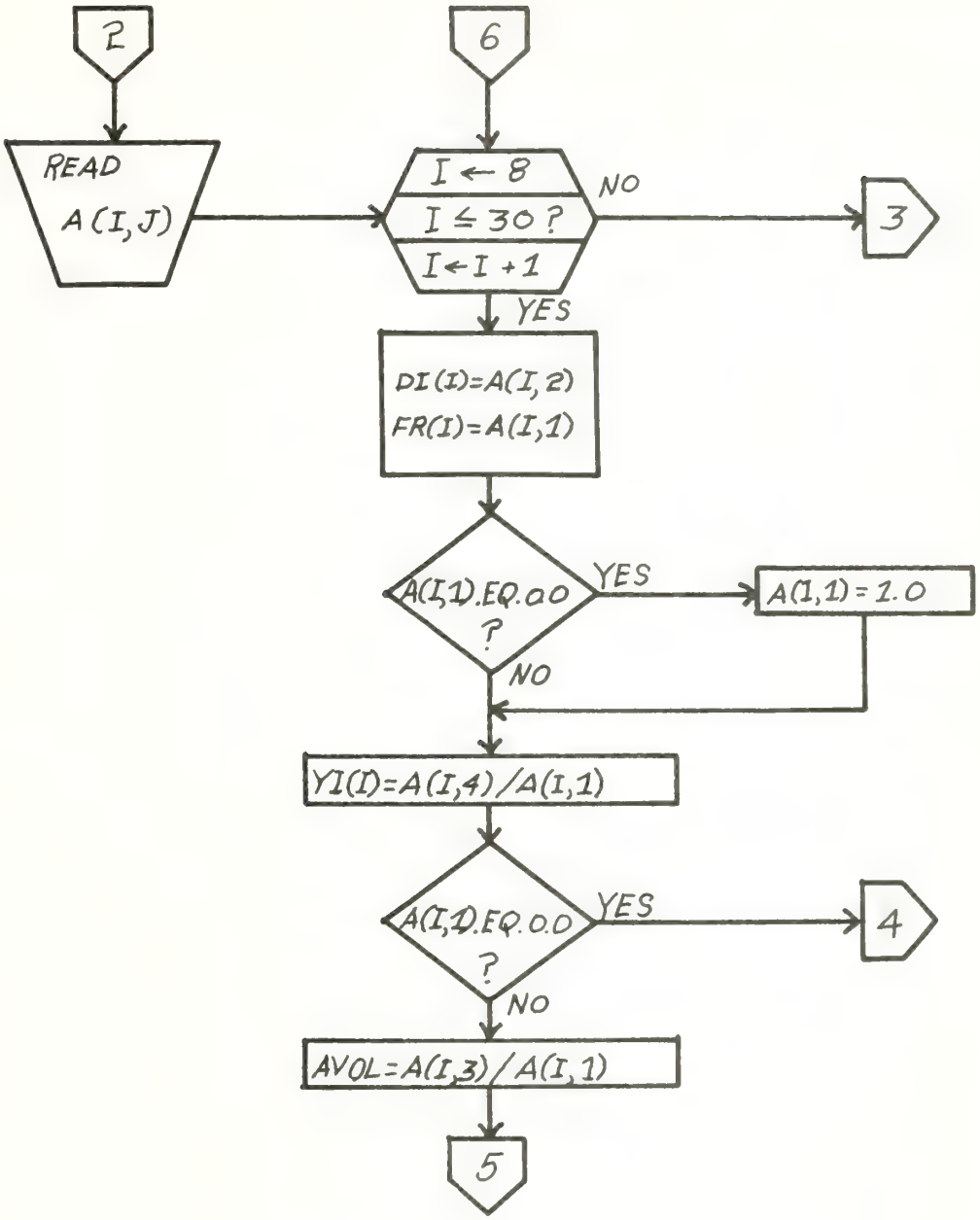
WTVAL = Proportionate lumber value per MBF by lumber grade, lumber thickness, and diameter class.

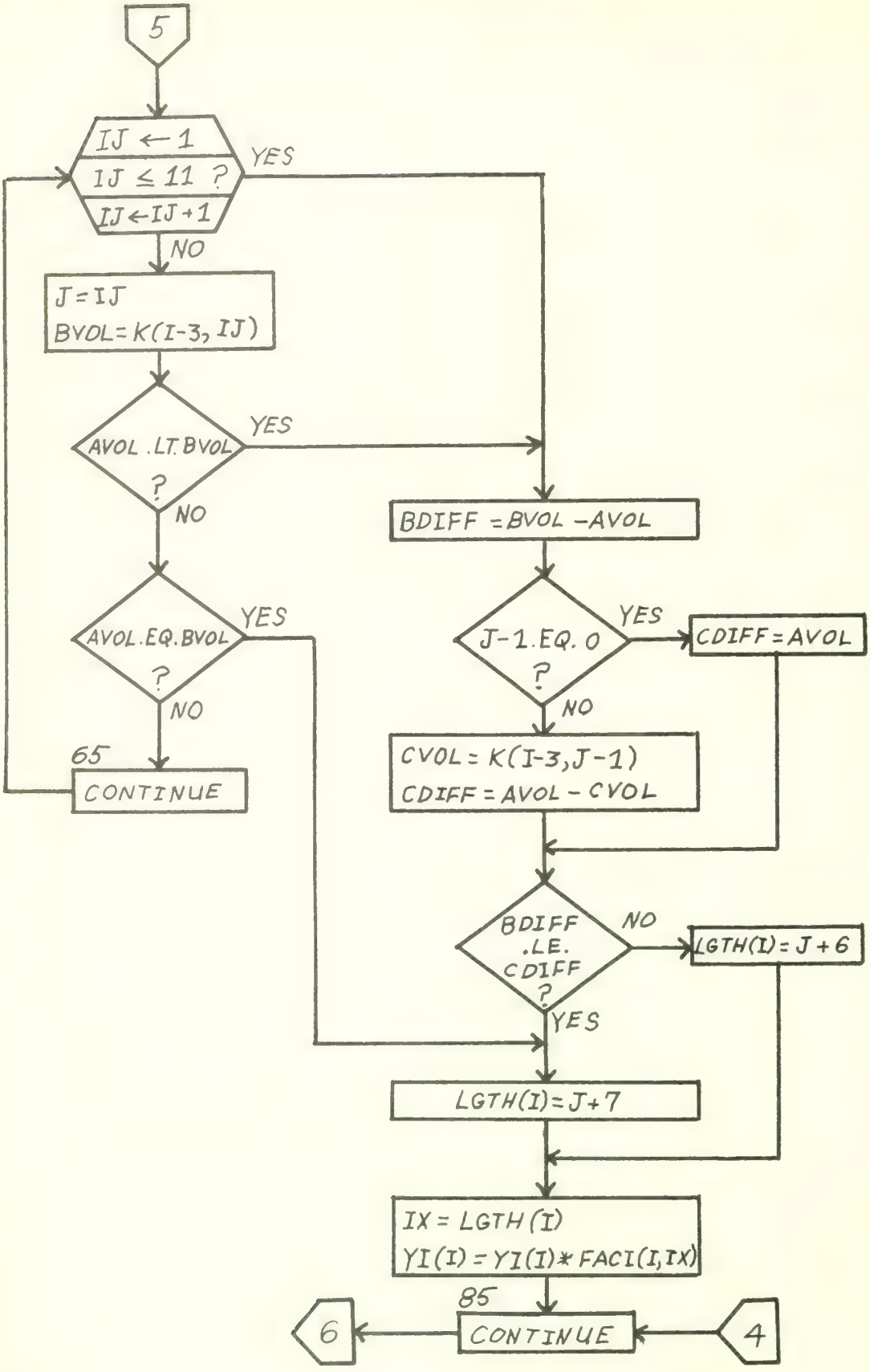
YI(I) = Uncurved average lumber tally by diameter class from FPL-63 data.

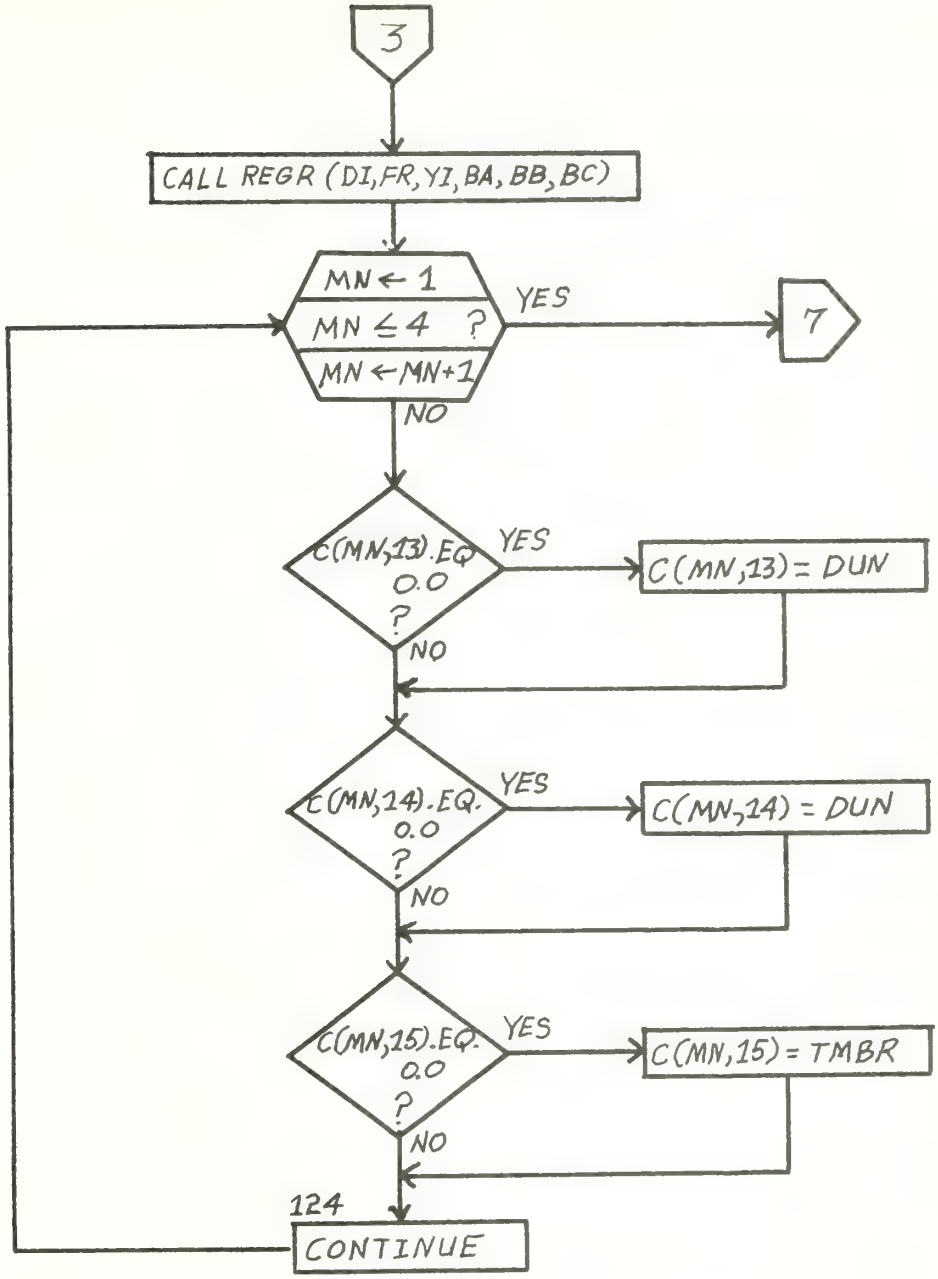
Flow Chart for Main Program

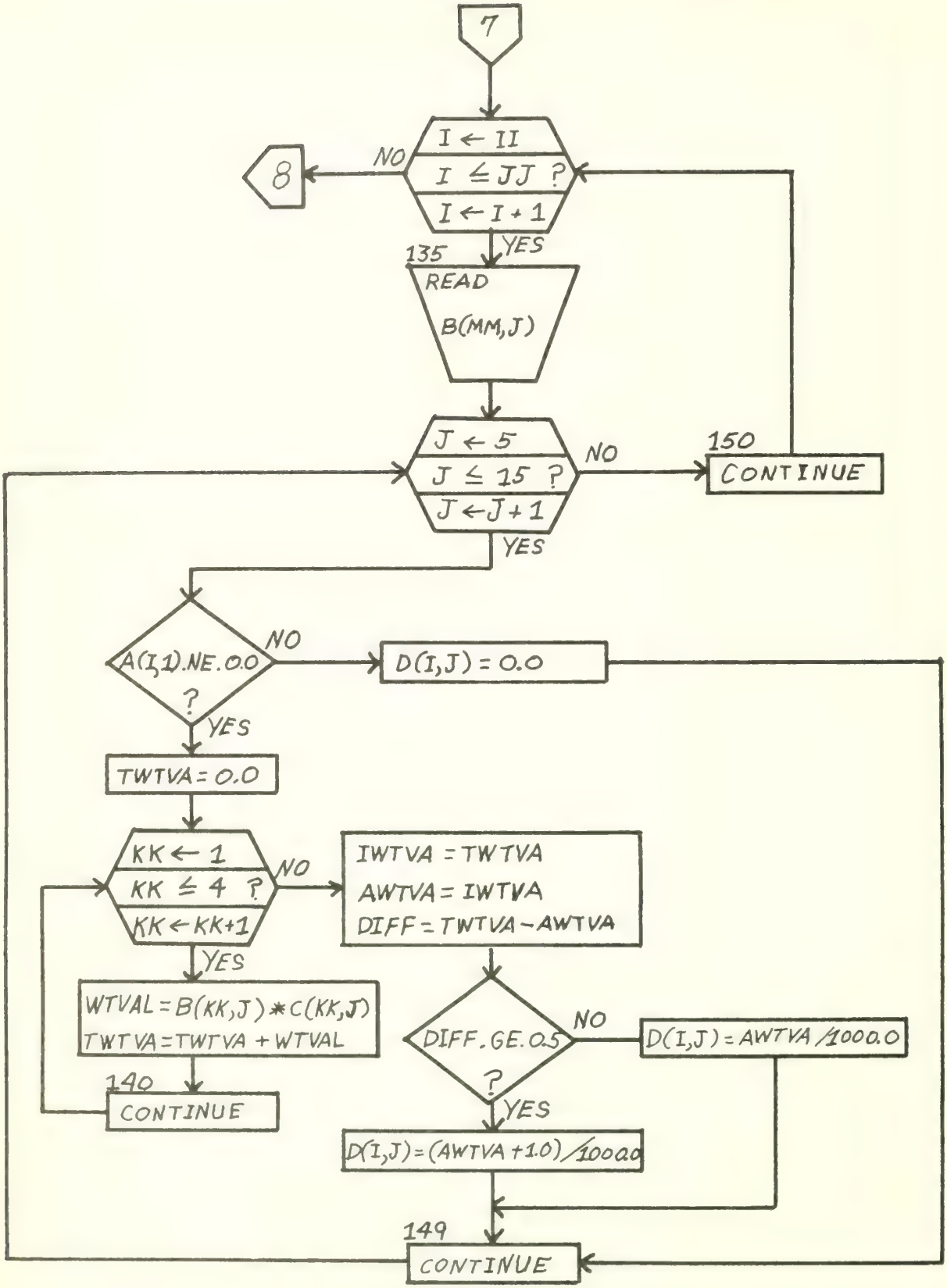


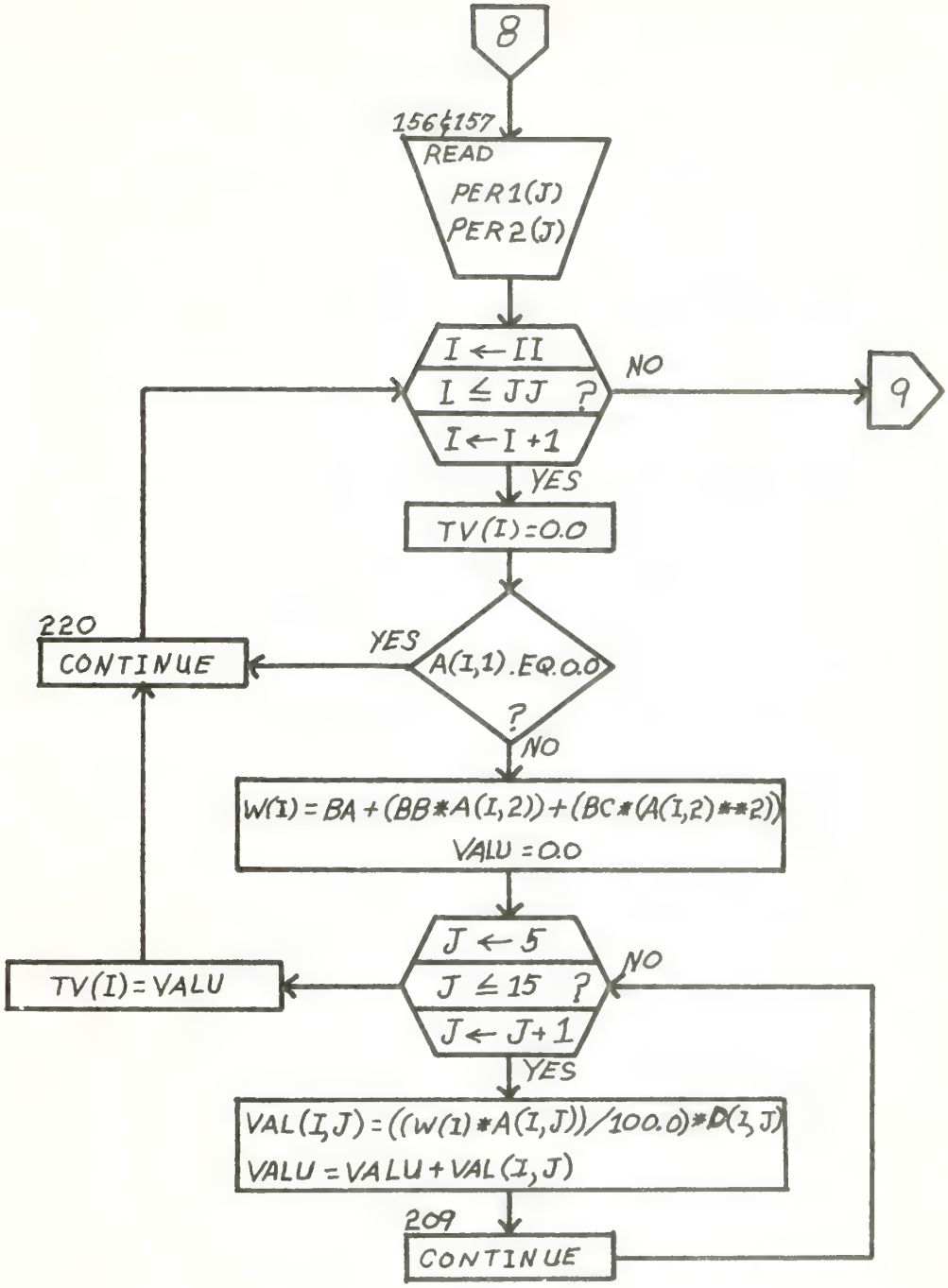

1
VA4=0.0
VB4=0.0
VC4=0.0
PERR=0.0
I ← 8
I ≤ 30 ?
I ← I+1
YES
2
NO
W(I)=0.0
TV(I)=0.0
J ← 1
J ≤ 5 ?
J ← J+1
YES
NO
E(I,J)=0.0
36
CONTINUE
J ← 1
J ≤ 15 ?
J ← J+1
YES
40
CONTINUE
NO
D(I,J)=0.0
A(I,J)=0.0
38
CONTINUE

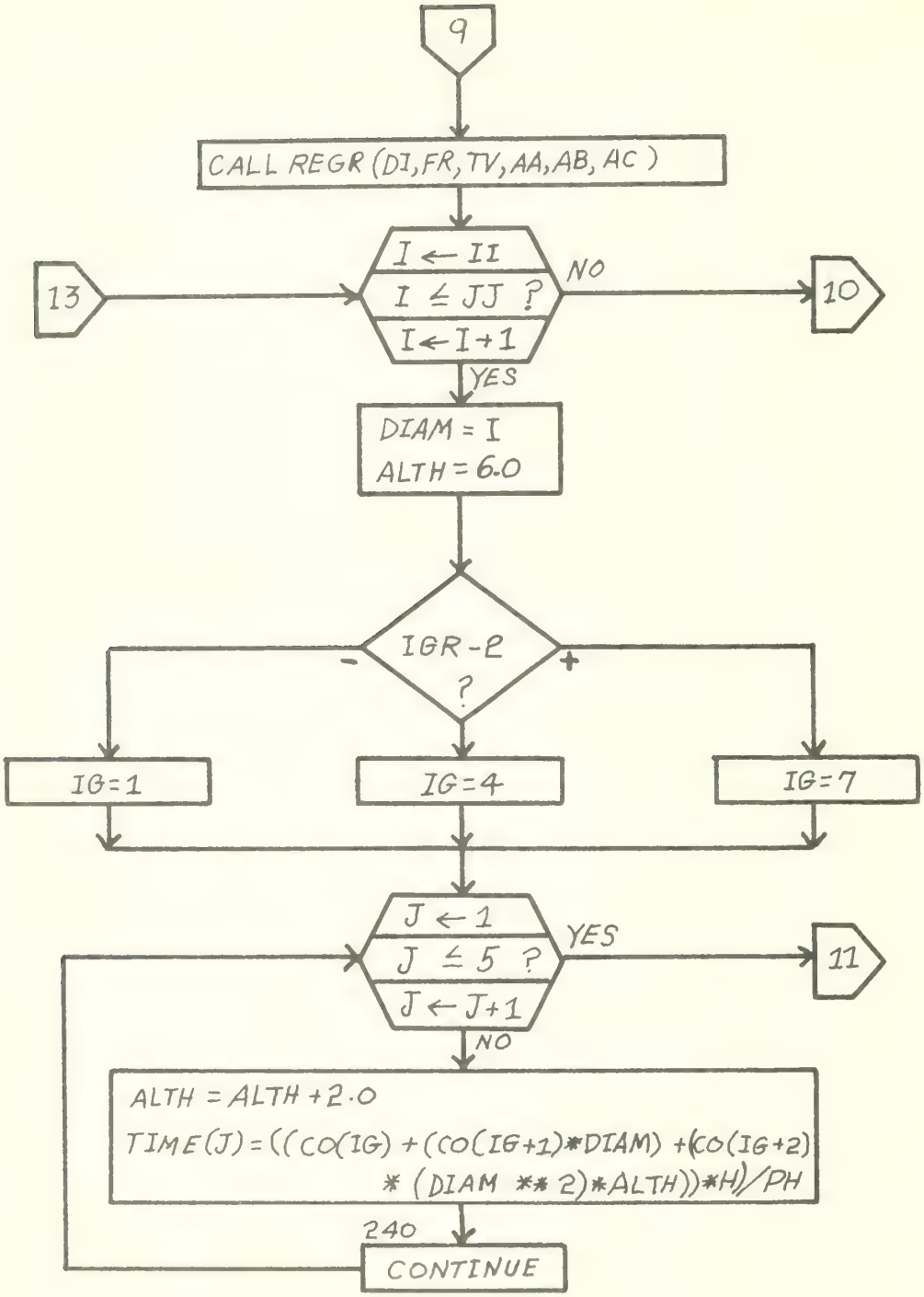

2
READ
A(I,J)
6
I ← 8
I ≤ 30 ?
I ← I + 1
NO
3
YES
DI(I)=A(I,2)
FR(I)=A(I,1)
A(I,1).EQ.00 ?
YES
A(1,1) = 1.0
NO
YI(I)=A(I,4)/A(I,1)
A(I,1).EQ.0.0 ?
YES
4
NO
AVOL=A(I,3)/A(I,1)
5

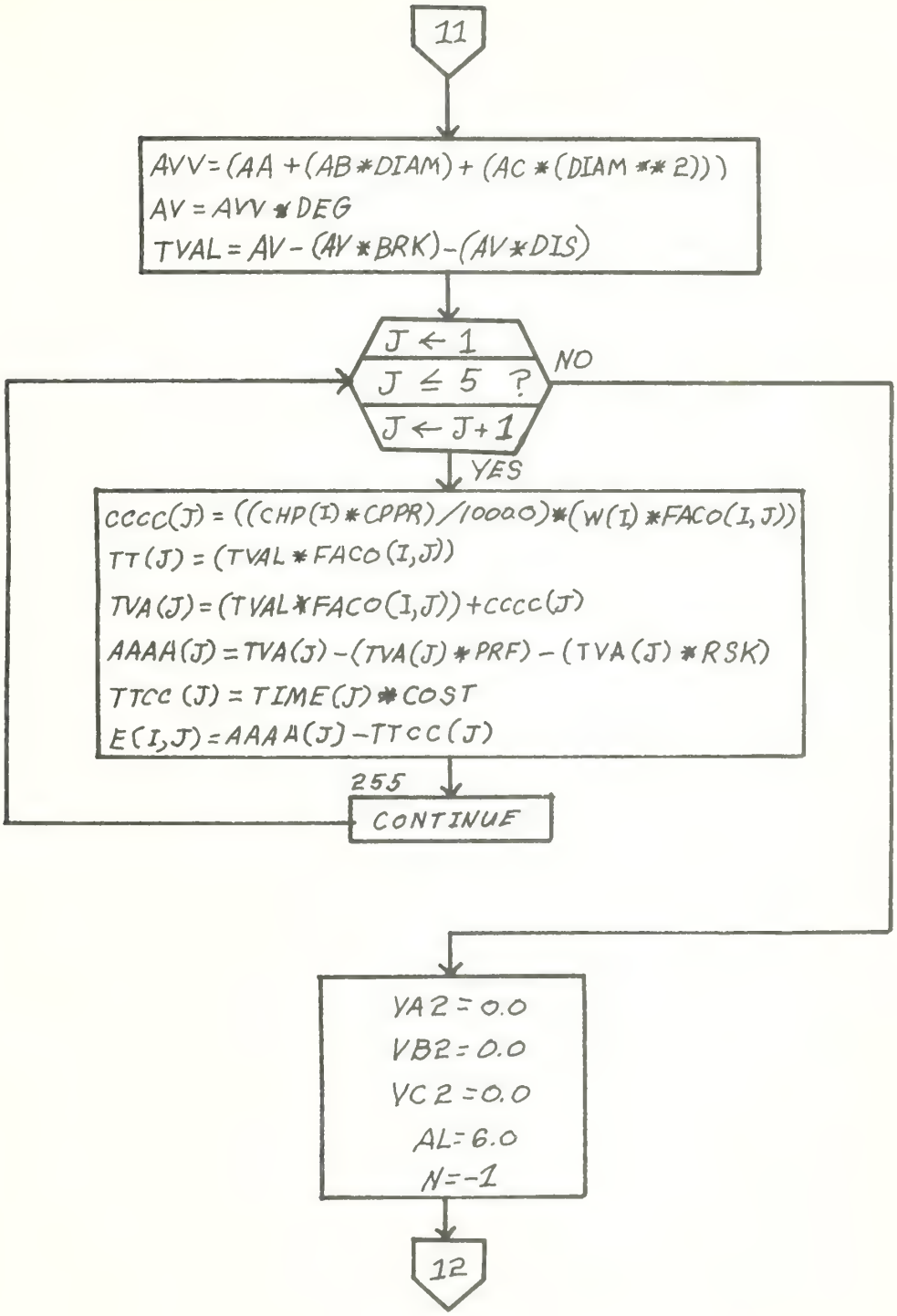

5
IJ ← 1
IJ ≤ 11 ?
IJ ← IJ + 1
YES
NO
J = IJ
BVOL = K(I-3, IJ)
AVOL .LT. BVOL ?
YES
NO
BDIFF = BVOL - AVOL
AVOL .EQ. BVOL ?
YES
NO
65
CONTINUE
J-1 .EQ. 0 ?
YES
CDIFF = AVOL
NO
CVOL = K(I-3, J-1)
CDIFF = AVOL - CVOL
BDIFF .LE. CDIFF ?
NO
LGTH(I) = J + 6
YES
LGTH(I) = J + 7
IX = LGTH(I)
YI(I) = YI(I) * FACI(I, IX)
85
CONTINUE
6
4

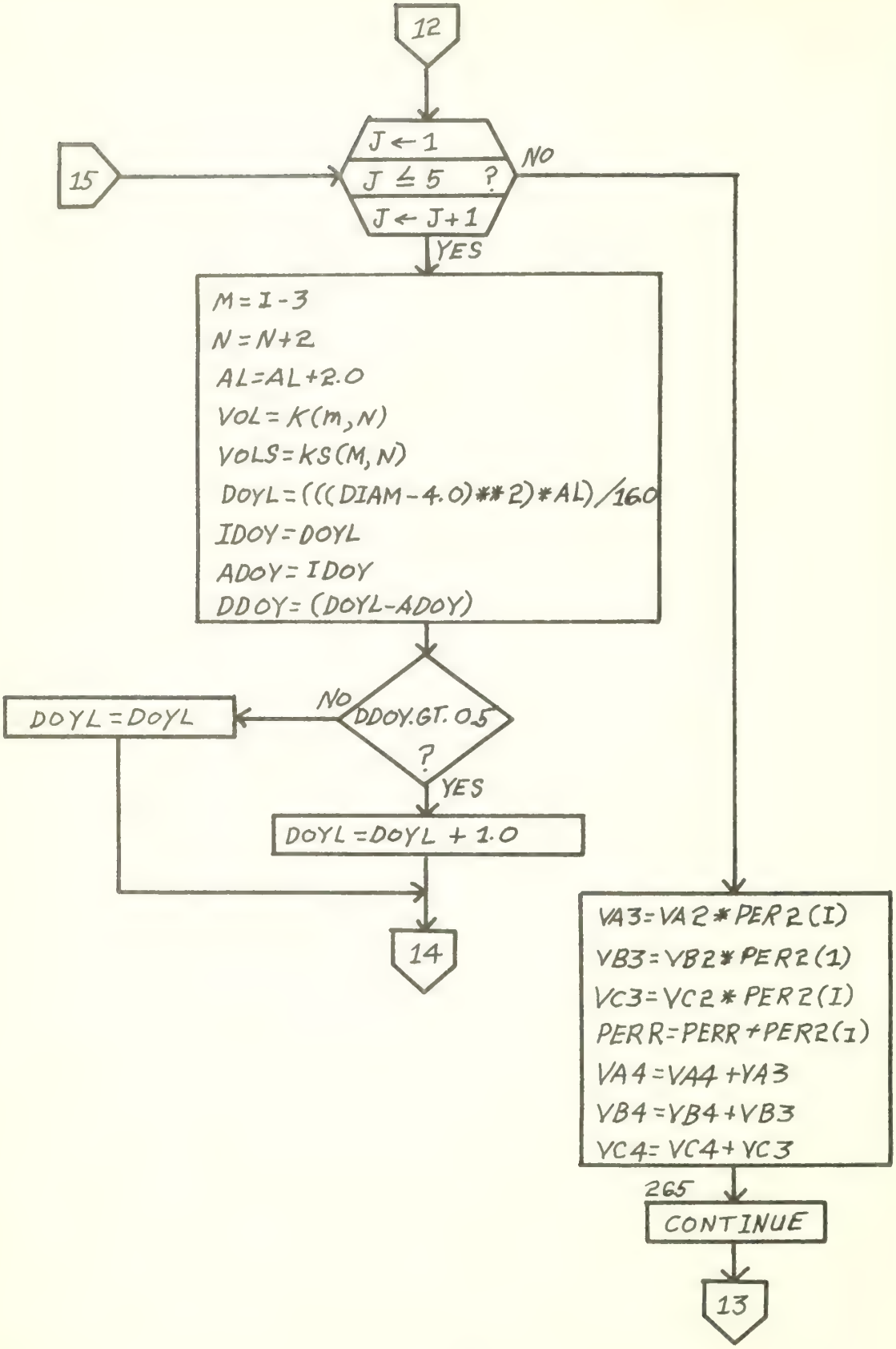

3
CALL REGR (DI,FR,YI,BA,BB,BC)
MN ← 1
MN ≤ 4 ?
MN ← MN+1
YES
7
NO
C(MN,13).EQ. 0.0 ?
YES
C(MN,13) = DUN
NO
C(MN,14).EQ. 0.0 ?
YES
C(MN,14) = DUN
NO
C(MN,15).EQ. 0.0 ?
YES
C(MN,15) = TMBR
NO
124
CONTINUE

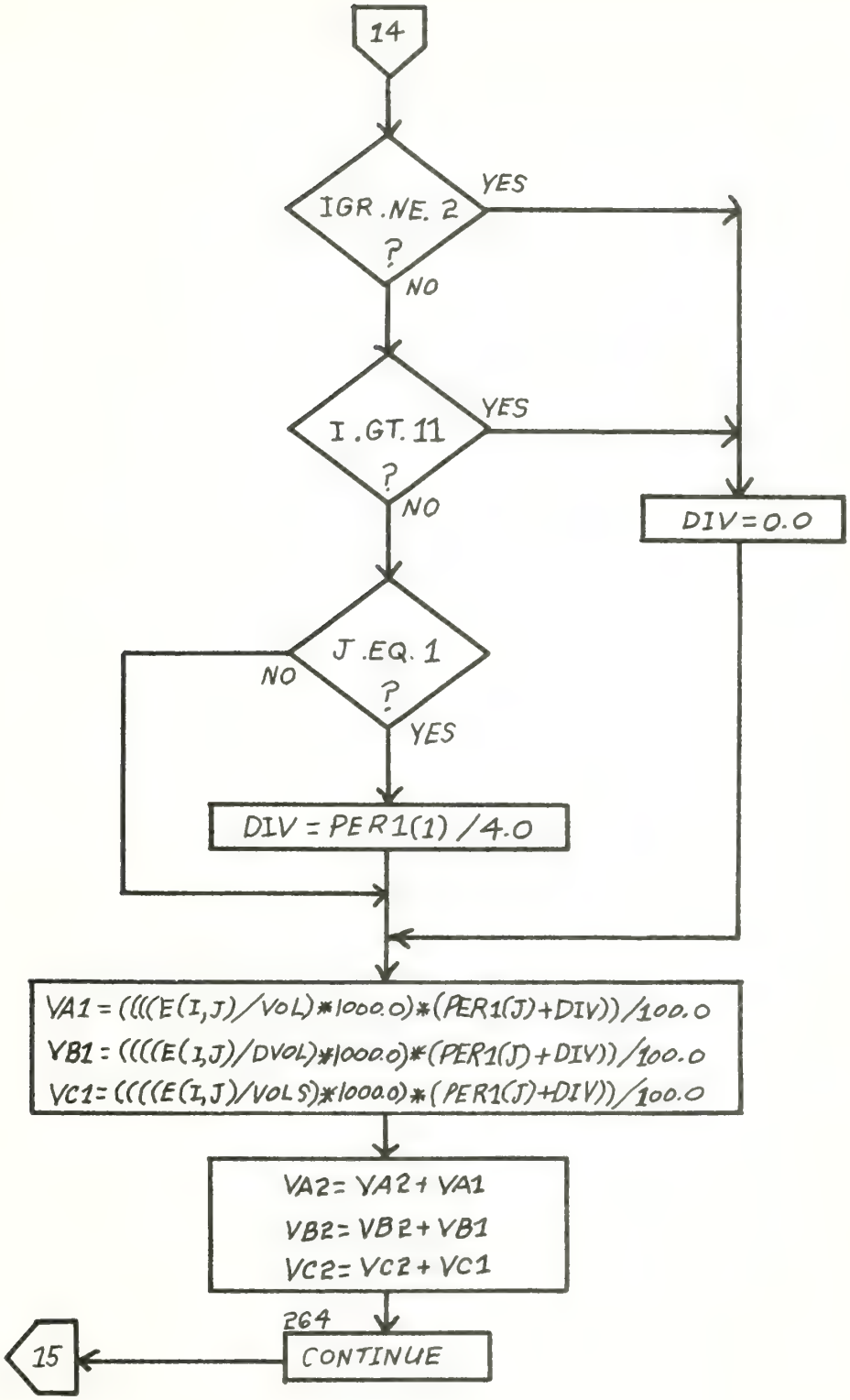

7
I ← II
I ≤ JJ ?
I ← I + 1
NO
8
YES
135
READ
B(MM,J)
J ← 5
J ≤ 15 ?
J ← J + 1
NO
150
CONTINUE
YES
A(I,1).NE.0.0 ?
NO
D(I,J) = 0.0
YES
TWTVA = 0.0
KK ← 1
KK ≤ 4 ?
KK ← KK+1
NO
YES
IWTVA = TWTVA
AWTVA = IWTVA
DIFF = TWTVA − AWTVA
WTVAL = B(KK,J) * C(KK,J)
TWTVA = TWTVA + WTVAL
140
CONTINUE
DIFF.GE.0.5 ?
NO
D(I,J) = AWTVA / 1000.0
YES
D(I,J) = (AWTVA + 1.0) / 1000.0
149
CONTINUE

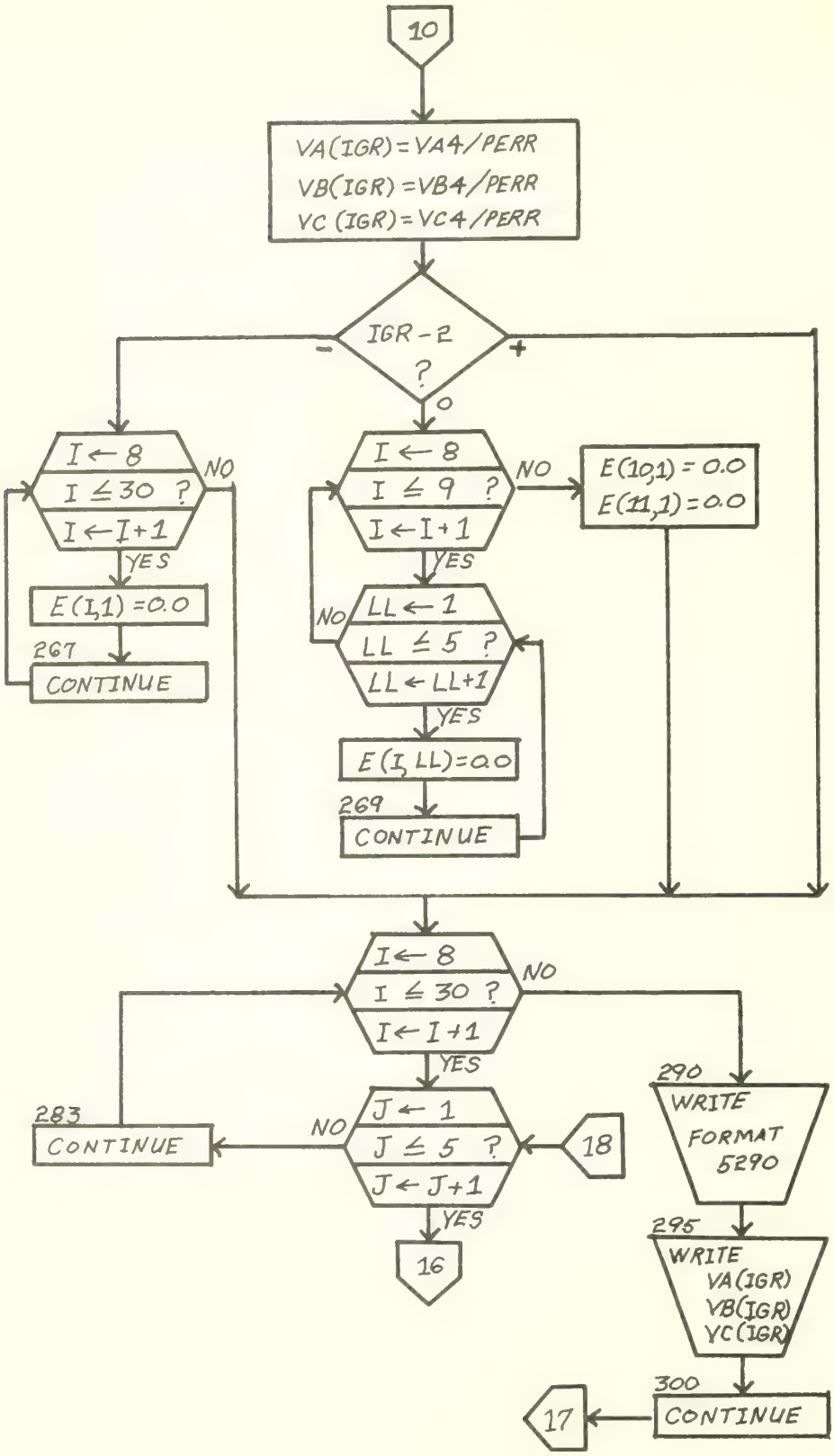

8
156&157
READ
PER1(J)
PER2(J)
I ← II
I ≤ JJ ?
I ← I + 1
NO
9
YES
TV(I)=0.0
220
CONTINUE
YES
A(I,1).EQ.0.0
?
NO
W(I) = BA + (BB*A(I,2)) + (BC*(A(I,2)**2))
VALU = 0.0
J ← 5
J ≤ 15 ?
J ← J + 1
NO
TV(I) = VALU
YES
VAL(I,J) = ((W(1)*A(I,J))/100.0)*D(I,J)
VALU = VALU + VAL(I,J)
209
CONTINUE

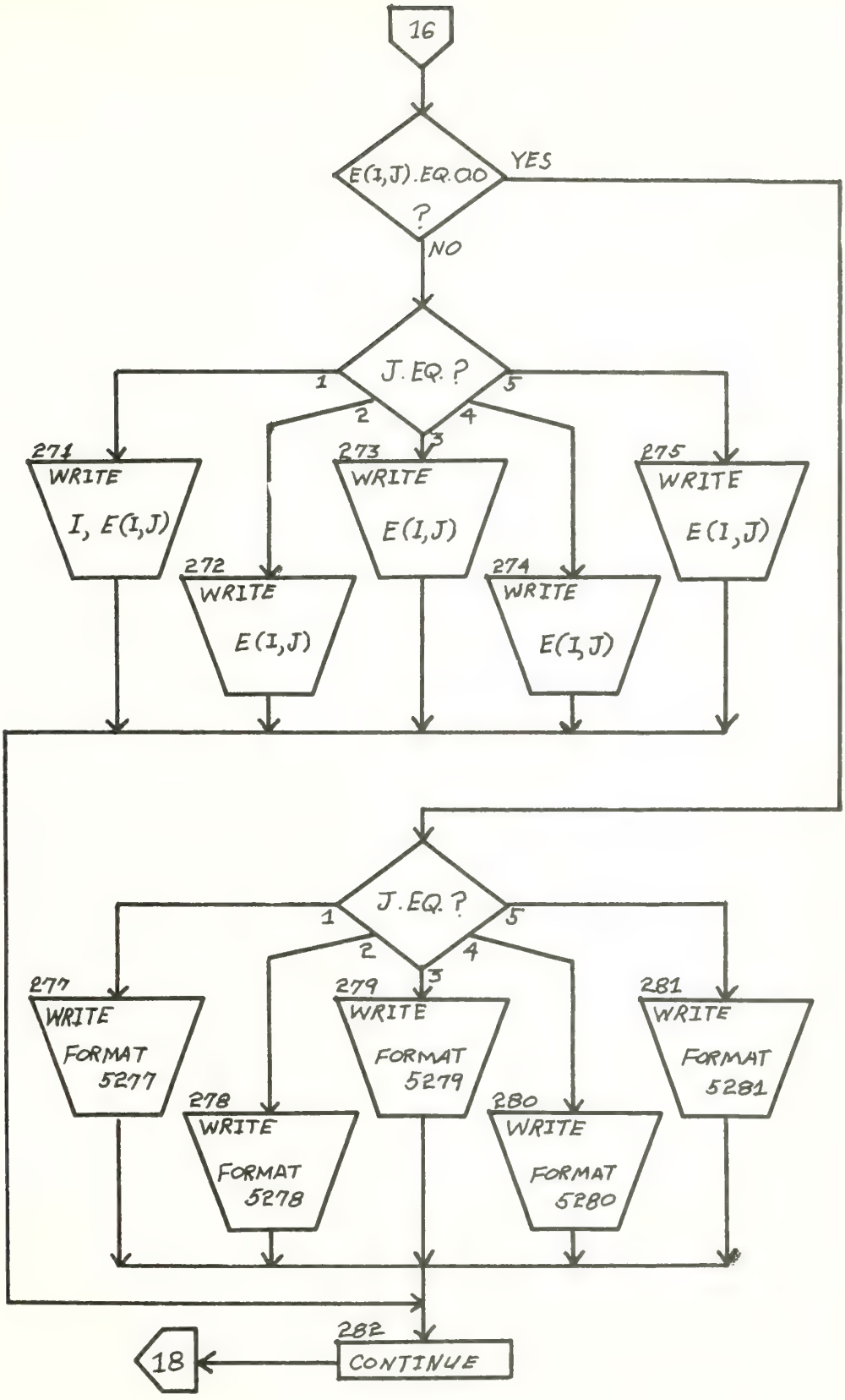

9
CALL REGR (DI,FR,TV,AA,AB,AC)
13
I ← II
I ≤ JJ ?
I ← I+1
NO
10
YES
DIAM = I
ALTH = 6.0
IGR-2
?
-
+
IG=1
IG=4
IG=7
J ← 1
J ≤ 5 ?
J ← J+1
YES
11
NO
ALTH = ALTH +2.0
TIME(J) = ((CO(IG) + (CO(IG+1)*DIAM) +(CO(IG+2)
* (DIAM ** 2)*ALTH))*H)/PH
240
CONTINUE


11
AVV=(AA+(AB*DIAM)+(AC*(DIAM**2)))
AV=AVV*DEG
TVAL=AV-(AV*BRK)-(AV*DIS)
J←1
J≤5 ?
J←J+1
NO
YES
CCCC(J)=((CHP(I)*CPPR)/10000)*(W(I)*FACO(I,J))
TT(J)=(TVAL*FACO(I,J))
TVA(J)=(TVAL*FACO(I,J))+CCCC(J)
AAAA(J)=TVA(J)-(TVA(J)*PRF)-(TVA(J)*RSK)
TTCC(J)=TIME(J)*COST
E(I,J)=AAAA(J)-TTCC(J)
255
CONTINUE
YA2=0.0
YB2=0.0
YC2=0.0
AL=6.0
N=-1
12


12
15
J ← 1
J ≤ 5 ?
J ← J+1
NO
YES
M = I-3
N = N+2
AL=AL+2.0
VOL = K(m,N)
VOLS = KS(M,N)
DOYL = (((DIAM-4.0)**2)*AL)/160
IDOY = DOYL
ADOY = IDOY
DDOY = (DOYL-ADOY)
DDOY.GT. 0.5 ?
NO
YES
DOYL = DOYL
DOYL = DOYL + 1.0
14
VA3 = VA2 * PER2(I)
VB3 = VB2 * PER2(1)
VC3 = VC2 * PER2(I)
PERR = PERR + PER2(I)
VA4 = VA4 + VA3
VB4 = VB4 + VB3
VC4 = VC4 + VC3
265
CONTINUE
13


14
IGR .NE. 2 ?
YES
NO
I .GT. 11 ?
YES
NO
DIV = 0.0
J .EQ. 1 ?
NO
YES
DIV = PER1(1) / 4.0
VA1 = ((((E(I,J)/VOL)*1000.0)*(PER1(J)+DIV))/100.0
VB1 = ((((E(I,J)/DVOL)*1000.0)*(PER1(J)+DIV))/100.0
VC1 = ((((E(I,J)/VOLS)*1000.0)*(PER1(J)+DIV))/100.0
VA2 = VA2 + VA1
VB2 = VB2 + VB1
VC2 = VC2 + VC1
264
CONTINUE
15


10
VA(IGR) = VA4/PERR
VB(IGR) = VB4/PERR
VC(IGR) = VC4/PERR
IGR - 2 ?
-
+
0
I ← 8
I ≤ 30 ?
I ← I+1
NO
YES
E(I,1) = 0.0
267
CONTINUE
I ← 8
I ≤ 9 ?
I ← I+1
NO
YES
E(10,1) = 0.0
E(11,1) = 0.0
LL ← 1
LL ≤ 5 ?
LL ← LL+1
NO
YES
E(I,LL) = 0.0
269
CONTINUE
I ← 8
I ≤ 30 ?
I ← I+1
NO
YES
283
CONTINUE
J ← 1
J ≤ 5 ?
J ← J+1
NO
YES
18
16
290
WRITE
FORMAT
5290
295
WRITE
VA(IGR)
VB(IGR)
VC(IGR)
300
CONTINUE
17


16
E(I,J).EQ.00 ?
YES
NO
J.EQ.?
1
2
3
4
5
271
WRITE
I, E(I,J)
272
WRITE
E(I,J)
273
WRITE
E(I,J)
274
WRITE
E(I,J)
275
WRITE
E(I,J)
J.EQ.?
1
2
3
4
5
277
WRITE
FORMAT
5277
278
WRITE
FORMAT
5278
279
WRITE
FORMAT
5279
280
WRITE
FORMAT
5280
281
WRITE
FORMAT
5281
282
CONTINUE
18

Program Listing for Main Program

```
C      'SOLVE' PROGRAM FOR DETERMINING THE MAXIMUM VALUE OF DELIVERED
C      HARDWOOD SAWLOGS.
C      NORTHEASTERN FOREST EXPERIMENT STATION - ADAMS - 1971
       DIMENSION K(37,11),A(30,15),C(4,15),B(4,15),D(30,15),VAL(30,15),SP
      1EC(5),CO(9),TIME(5),E(30,5),CHP(30),DI(30),FR(30),TV(30),YI(30),TV
      2A(10),LGTH(30),W(30),VA(3),VB(3),PER1(5),PER2(30),PER3(3),F(30,5),
      3AAAA(5),CCCC(5),TTCC(5),FACI(30,16),FACO(30,5),KS(37,11),VC(3),MIL
      4L(7),TT(5)
     1 IR=5
     2 IW=6
     5 READ(IR,5005) ((K(I,J),J=1,11),I=1,37)
  5005 FORMAT(11I5)
     6 READ(IR,5006) ((FACI(I,J),J=7,16),I=8,30)
  5006 FORMAT(10F5.3)
     7 READ(IR,5007) ((FACO(I,J),J=1,5),I=8,30)
  5007 FORMAT(5F5.3)
     8 READ(IR,5005) ((KS(I,J),J=1,11),I=1,37)
     9 READ(IR,5009) (MILL(I),I=1,7)
  5009 FORMAT(7A4)
    10 READ(IR,5010) MNTH,IDAY,IYEAR,COST,CPPR,DUN,TMBR,PRF,RSK,BRK,DIS,P
      1H,H
  5010 FORMAT(3I3,2F6.2,2F4.0,4F4.2,2F6.2)
    11 READ(IR,5011) NO
  5011 FORMAT(I3)
       DO 310 ISP=1,NO
    15 READ(IR,5015) (SPEC(I),I=1,5)
  5015 FORMAT(5A4)
    20 READ(IR,5020) ((C(I,J),J=5,15),I=1,4)
  5020 FORMAT(5X,11F4.0)
    25 READ(IR,5025) (CO(I),I=1,9)
  5025 FORMAT(6X,3F10.5/6X,3F10.5/6X,3F10.5)
    30 READ(IR,5030) (CHP(I),I=8,25)
  5030 FORMAT(4X,18F4.2)
       DO 31 I=26,30
       CHP(I)=CHP(25)
    31 CONTINUE
       DO 300 IGR=1,3
    32 WRITE(IW,5032) MILL,SPEC,IGR,MNTH,IDAY,IYEAR
  5032 FORMAT(1H1,28X,7A4//1H ,28X,21HMAXIMUM SAWLOG VALUES//1H ,28X,5A4/
      1/1H ,28X,5HGRADE,I3//1H ,28X,5HDATE ,I3,1H/,I3,1H/,I3//)
    33 WRITE(IW,5033) COST
  5033 FORMAT(1H ,14X,40(1H*)/1H ,29X,7HSAWMILL/1H ,20X,23HCONV. COST PER
      1 MIN. = $,F5.2/1H ,14X,40(1H*)/1H ,14X,5HDIAM*,14X,6HLENGTH/1H ,14
      2X,38H    *     8      10      12      14      16/1H ,14X,40(1H*)/1H ,18
      3X,36H* ----- DOLLAR VALUES PER LOG ----- /1H ,18X,1H*)
    35 READ(IR,5035) II,JJ,DEG
  5035 FORMAT(5X,2I3,F4.2)
       VA4=0.0
       VB4=0.0
       VC4=0.0
```

```
      PERR=0.0
      DO 40 I=8,30
      W(I)=0.0
      TV(I)=0.0
      DO 36 J=1,5
      E(I,J)=0.0
   36 CONTINUE
      DO 38 J=1,15
      D(I,J)=0.0
      A(I,J)=0.0
   38 CONTINUE
   40 CONTINUE
   45 READ(IR,5045) ((A(I,J),J=1,15),I=II,JJ)
 5045 FORMAT(4X,2F3.0,F5.0,9X,F5.0,11F4.1)
   50 DO 85 I=8,30
   52 DI(I)=A(I,2)
      FR(I)=A(I,1)
      IF(A(I,1).EQ.0.0) A(I,1)=1.0
      YI(I)=A(I,4)/A(I,1)
      IF(A(I,1).EQ.0.0) GO TO 85
      AVOL=A(I,3)/A(I,1)
   60 DO 65 IJ=1,11
      J=IJ
      BVOL=K(I-3,IJ)
      IF(AVOL.LT.BVOL) GO TO 70
      IF(AVOL.EQ.BVOL) GO TO 73
   65 CONTINUE
   70 BDIFF=BVOL-AVOL
      IF(J-1.EQ.0) GO TO 71
      CVOL=K(I-3,J-1)
      CDIFF=AVOL-CVOL
      GO TO 72
   71 CDIFF=AVOL
   72 IF(BDIFF.LE.CDIFF) GO TO 73
      LGTH(I)=J+6
      GO TO 74
   73 LGTH(I)=J+7
   74 IX=LGTH(I)
      YI(I)=YI(I)*FACI(I,IX)
   85 CONTINUE
  100 CALL REGR(DI,FR,YI,BA,BB,BC)
      DO 124 MN=1,4
      IF(C(MN,13).EQ.0.0) C(MN,13)=DUN
      IF(C(MN,14).EQ.0.0) C(MN,14)=DUN
      IF(C(MN,15).EQ.0.0) C(MN,15)=TMBR
  124 CONTINUE
  126 DO 150 I=II,JJ
  135 READ(IR,5135) ((B(MM,J),J=5,15),MM=1,4)
 5135 FORMAT(11X,11F5.3)
      DO 149 J=5,15
```

```
      IF(A(I,1).NE.0.0) GO TO 139
      D(I,J)=0.0
      GO TO 149
  139 TWTVA=0.0
      DO 140 KK=1,4
      WTVAL=B(KK,J)*C(KK,J)
      TWTVA=TWTVA+WTVAL
  140 CONTINUE
      IWTVA=TWTVA
      AWTVA=IWTVA
      DIFF=IWTVA-AWTVA
      IF(DIFF.GE.0.5) GO TO 145
      D(I,J)=AWTVA/1000.0
      GO TO 149
  145 D(I,J)=(AWTVA+1.0)/1000.0
  149 CONTINUE
  150 CONTINUE
  156 READ(IR,5156) (PER1(J),J=1,5)
 5156 FORMAT(5X,5F4.0)
  157 READ(IR,5157) (PER2(J),J=8,30)
 5157 FORMAT(5X,23F3.0)
  200 DO 220 I=II,JJ
      TV(I)=0.0
      IF(A(I,1).EQ.0.0) GO TO 220
  205 W(I)=BA+(BB*A(I,2))+(BC*(A(I,2)**2))
      VALU=0.0
      DO 209 J=5,15
      VAL(I,J)=((W(I)*A(I,J))/100.0)*D(I,J)
      VALU=VALU+VAL(I,J)
  209 CONTINUE
  219 TV(I)=VALU
  220 CONTINUE
      CALL REGR(DI,FR,TV,AA,AB,AC)
  225 DO 265 I=II,JJ
      DIAM=I
      ALTH=6.0
      IF(IGR-2) 230,231,232
  230 IG=1
      GO TO 235
  231 IG=4
      GO TO 235
  232 IG=7
  235 DO 240 J=1,5
      ALTH=ALTH+2.0
      TIME(J)=((CO(IG)+(CO(IG+1)*DIAM)+(CO(IG+2)*(DIAM**2)*ALTH))*H)/PH
  240 CONTINUE
  250 AVV=(AA+(AB*DIAM)+(AC*(DIAM**2)))
      AV=AVV*DEG
      TVAL=AV-(AV*BRK)-(AV*DIS)
      DO 255 J=1,5
```

```
      CCCC(J)=((CHP(I)*CPPR)/1000.0)*(W(I)*FACO(I,J))
      TT(J)=(TVAL*FACO(I,J))
      TVA(J)=(TVAL*FACO(I,J))+CCCC(J)
      AAAA(J)=TVA(J)-(TVA(J)*PRF)-(TVA(J)*KSK)
      TTCC(J)=TIME(J)*COST
      E(I,J)=AAAA(J)-TTCC(J)
255   CONTINUE
      VA2=0.0
      VB2=0.0
      VC2=0.0
      AL=6.0
      N=-1
      DO 264 J=1,5
      M=I-3
      N=N+2
      AL=AL+2.0
      VOL=K(M,N)
      VOLS=KS(M,N)
      DOYL=(((DIAM-4.0)**2)*AL)/16.0
      IDOY=DOYL
      ADOY=IDOY
      DDOY=(DOYL-ADOY)
      IF(DDOY.GT.0.5) GO TO 256
      DOYL=DOYL
      GO TO 257
256   DOYL=DOYL+1.0
257   IF(IGR.NE.2) GO TO 259
      IF(I.GT.11) GO TO 259
      IF(J.EQ.1) DIV=PER1(1)/4.0
      GO TO 260
259   DIV=0.0
260   VA1=((((E(I,J)/VOL)*1000.0)*(PER1(J)+DIV))/100.0)
      VB1=((((E(I,J)/DOYL)*1000.0)*(PER1(J)+DIV))/100.0)
      VC1=((((E(I,J)/VOLS)*1000.0)*(PER1(J)+DIV))/100.0)
263   VA2=VA2+VA1
      VB2=VB2+VB1
      VC2=VC2+VC1
264   CONTINUE
      VA3=VA2*PER2(I)
      VB3=VB2*PER2(I)
      VC3=VC2*PER2(I)
      PERR=PERR+PER2(I)
      VA4=VA4+VA3
      VB4=VB4+VB3
      VC4=VC4+VC3
265   CONTINUE
      VA(IGR)=VA4/PERR
      VB(IGR)=VB4/PERR
      VC(IGR)=VC4/PERR
      IF(IGR-2) 266,268,270
```

```
 266 DO 267 I=8,30
     E(I,1)=0.0
 267 CONTINUE
     GO TO 270
 268 DO 269 I=8,9
     DO 269 LL=1,5
     E(I,LL)=0.0
 269 CONTINUE
     E(10,1)=0.0
     E(11,1)=0.0
 270 DO 283 I=8,30
     DO 282 J=1,5
     IF(E(I,J).EQ.0.0) GO TO 276
     GO TO (271,272,273,274,275),J
 271 WRITE(IW,5271) I,E(I,J)
5271 FORMAT(1H ,14X,I3,1X,1H*,F7.2)
     GO TO 282
 272 WRITE(IW,5272) E(I,J)
5272 FORMAT(1H+,26X,F7.2)
     GO TO 282
 273 WRITE(IW,5273) E(I,J)
5273 FORMAT(1H+,33X,F7.2)
     GO TO 282
 274 WRITE(IW,5274) E(I,J)
5274 FORMAT(1H+,40X,F7.2)
     GO TO 282
 275 WRITE(IW,5275) E(I,J)
5275 FORMAT(1H+,47X,F7.2)
     GO TO 282
 276 GO TO (277,278,279,280,281),J
 277 WRITE(IW,5277) I
5277 FORMAT(1H ,14X,I3,1X,1H*,3X,3H- -)
     GO TO 282
 278 WRITE(IW,5278)
5278 FORMAT(1H+,29X,3H- -)
     GO TO 282
 279 WRITE(IW,5279)
5279 FORMAT(1H+,36X,3H- -)
     GO TO 282
 280 WRITE(IW,5280)
5280 FORMAT(1H+,43X,3H- -)
     GO TO 282
 281 WRITE(IW,5281)
5281 FORMAT(1H+,50X,3H- -)
 282 CONTINUE
 283 CONTINUE
 290 WRITE(Iw,5290)
5290 FORMAT(1H ,18X,1H*/1H ,14X,40(1H*))
 295 WRITE(IW,5295) VA(IGR),VB(IGR),VC(IGR)
5295 FORMAT(1H ,18X,F7.2,25H = VALUE / MBF (INT. 1/4)/1H ,18X,F7.2,22H
```

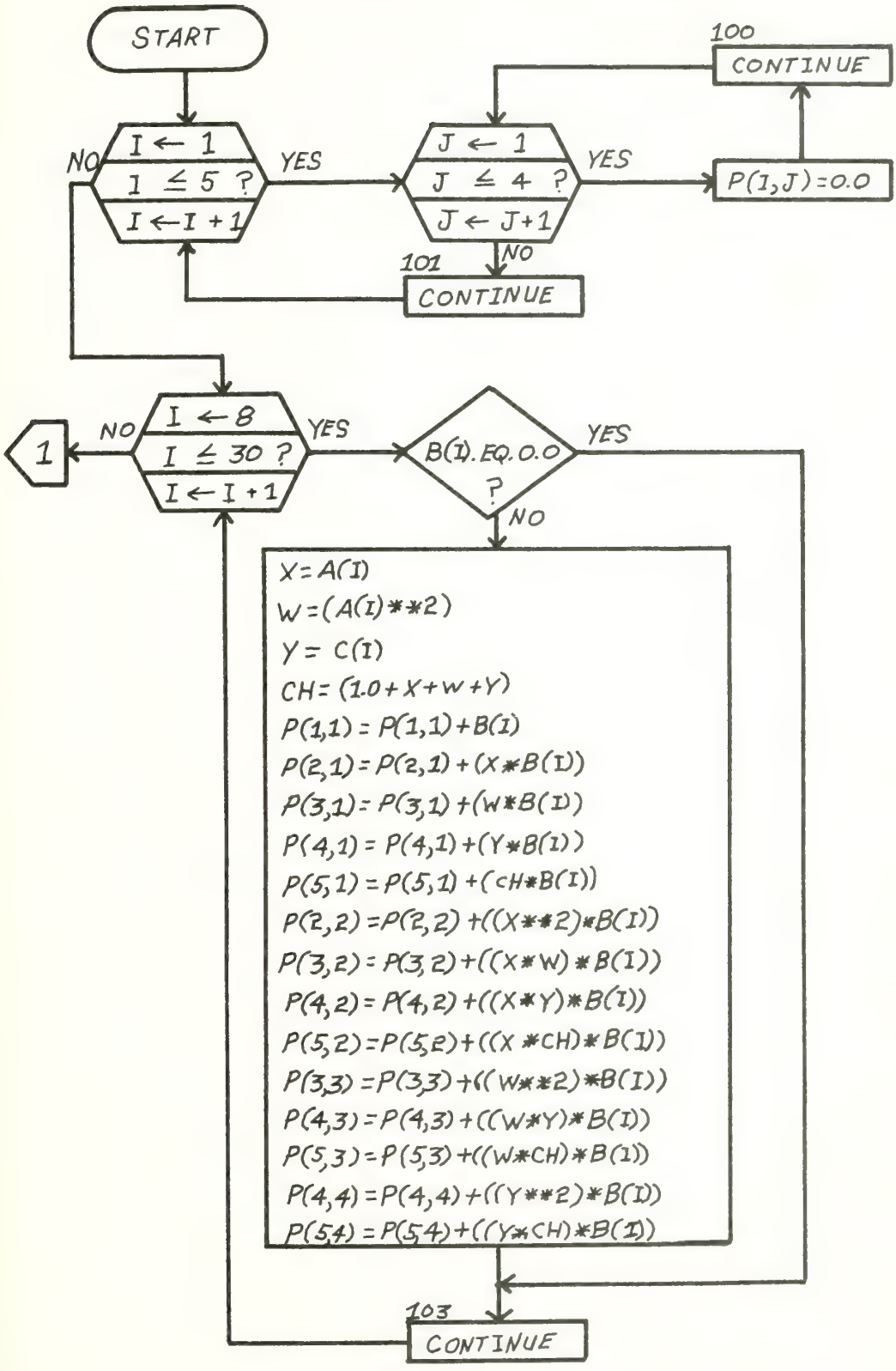
```
   1= VALUE / MBF (DOYLE)/1H ,18X,F7.2,30H = VALUE / MBF (SCRIB. DEC.
   2C)//1H ,14X,40(1H*))
300 CONTINUE
310 CONTINUE
    STOP
    END
```

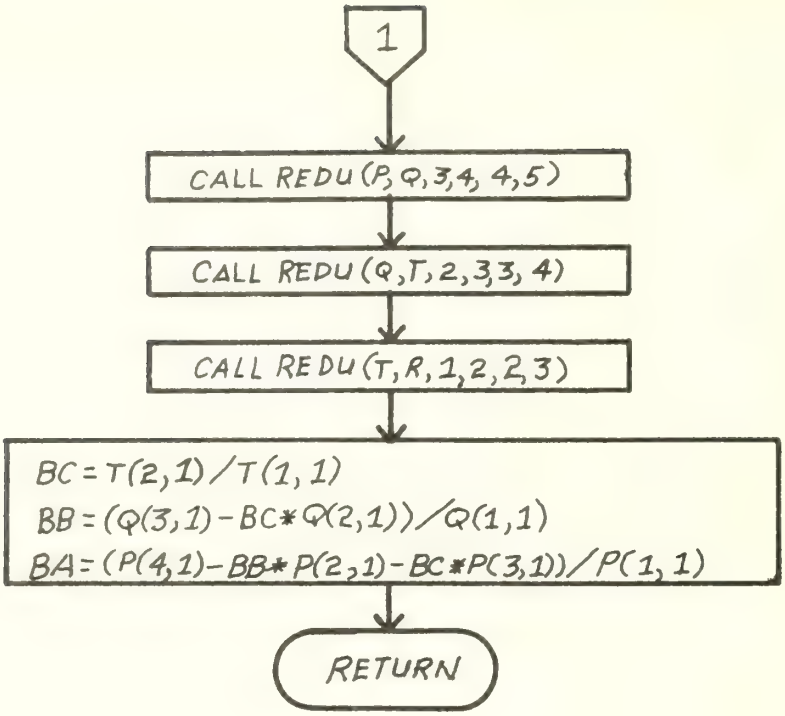
APPENDIX B

List of Variables for Subroutine REGR

A(I)	=	Independent variable.
B(I)	=	Weight to be applied to each pair of observations.
BA,BB,BC	=	Co-efficients for the following model: $Y = b_o + b_1X + b_2X^2$
C(I)	=	Dependent variable.
CH	=	Value used in calculating the check column in the sums of squares and cross product matrix.
P(I,J)	=	Sums of squares and cross-products matrix for a least-squares regression analysis.
Q(I,J)	=	First reduced matrix and checks for a least-squares regression analysis.
R(I,J)	=	Residual sums of squares and check for a least-squares regression analysis.
REDU (P,Q,3,4,4,5)	=	A subroutine for reducing the sums of squares and cross-products matrix to a residual sums of squares.
T(I,J)	=	Second reduced matrix and checks for a least-squares regression analysis.
W	=	Independent variable squared.

Flow Chart for Subroutine REGR




1
CALL REDU(P,Q,3,4,4,5)
CALL REDU(Q,T,2,3,3,4)
CALL REDU(T,R,1,2,2,3)
BC=T(2,1)/T(1,1)
BB=(Q(3,1)-BC*Q(2,1))/Q(1,1)
BA=(P(4,1)-BB*P(2,1)-BC*P(3,1))/P(1,1)
RETURN

Program Listing for Subroutine REGR

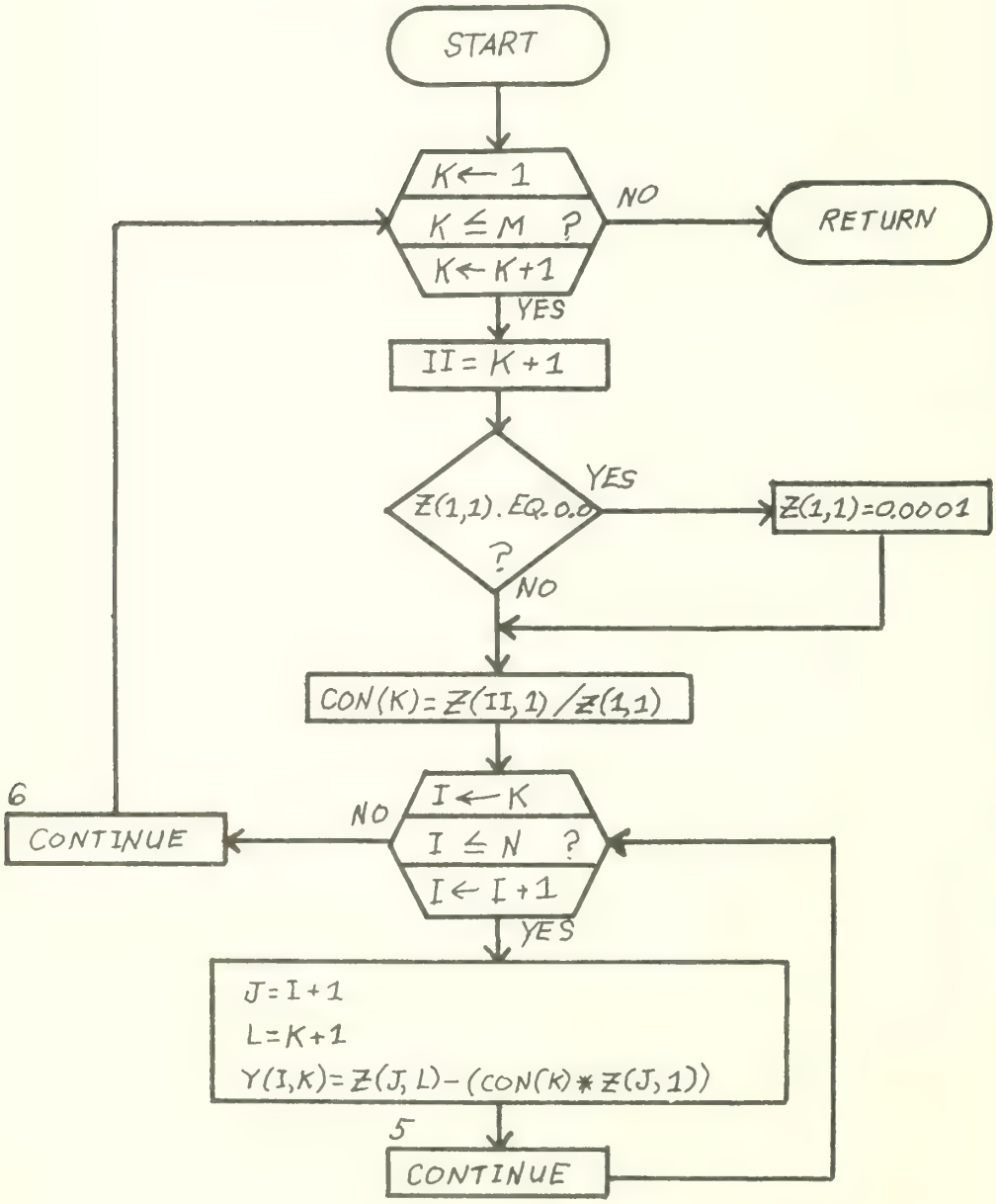
```
      SUBROUTINE REGR(A,B,C,BA,BB,BC)
      DIMENSION A(30),B(30),C(30),P(5,4),Q(4,3),T(3,2),R(2,1)
      DO 101 I=1,5
      DO 100 J=1,4
      P(I,J)=0.0
  100 CONTINUE
  101 CONTINUE
  102 DO 103 I=8,30
      IF(B(I).EQ.0.0) GO TO 103
      X=A(I)
      W=(A(I)**2)
      Y=C(I)
      CH=(1.0+X+W+Y)
      P(1,1)=P(1,1)+B(I)
      P(2,1)=P(2,1)+(X*B(I))
      P(3,1)=P(3,1)+(W*B(I))
      P(4,1)=P(4,1)+(Y*B(I))
      P(5,1)=P(5,1)+(CH*B(I))
      P(2,2)=P(2,2)+((X**2)*B(I))
      P(3,2)=P(3,2)+((X*W)*B(I))
      P(4,2)=P(4,2)+((X*Y)*B(I))
      P(5,2)=P(5,2)+((X*CH)*B(I))
      P(3,3)=P(3,3)+((W**2)*B(I))
      P(4,3)=P(4,3)+((W*Y)*B(I))
      P(5,3)=P(5,3)+((W*CH)*B(I))
      P(4,4)=P(4,4)+((Y**2)*B(I))
      P(5,4)=P(5,4)+((Y*CH)*B(I))
  103 CONTINUE
      CALL REDU(P,Q,3,4,4,5)
      CALL REDU(Q,T,2,3,3,4)
      CALL REDU(T,R,1,2,2,3)
      BC=T(2,1)/T(1,1)
      BB=(Q(3,1)-BC*Q(2,1))/Q(1,1)
      BA=(P(4,1)-BB*P(2,1)-BC*P(3,1))/P(1,1)
      RETURN
      END
```

APPENDIX C

List of Variables for Subroutine REDU

CON(K)	= A calculated constant used in the matrix reduction process.	M	= The number of rows in the reduced matrix.
I1	= The number of columns in the matrix to be reduced.	N	= The number of columns in the reduced matrix.
I2	= The number of rows in the matrix to be reduced.	Y(N,M)	= Reduced matrix.
		Z(I1,I2)	= Matrix to be reduced.

Flow Chart for Subroutine REDU



Program Listing for Subroutine REDU

```
      SUBROUTINE REDU(Z,Y,M,N,I2,I1)
      DIMENSION Z(I1,I2),Y(N,M),CON(9)
      DO 6 K=1,M
      II=K+1
      IF(Z(1,1).EQ.0.0) Z(1,1)=0.0001
      CON(K)=Z(II,1)/Z(1,1)
      DO 5 I=K,N
      J=I+1
      L=K+1
      Y(I,K)=Z(J,L)-(CON(K)*Z(J,1))
    5 CONTINUE
    6 CONTINUE
      RETURN
      END
```

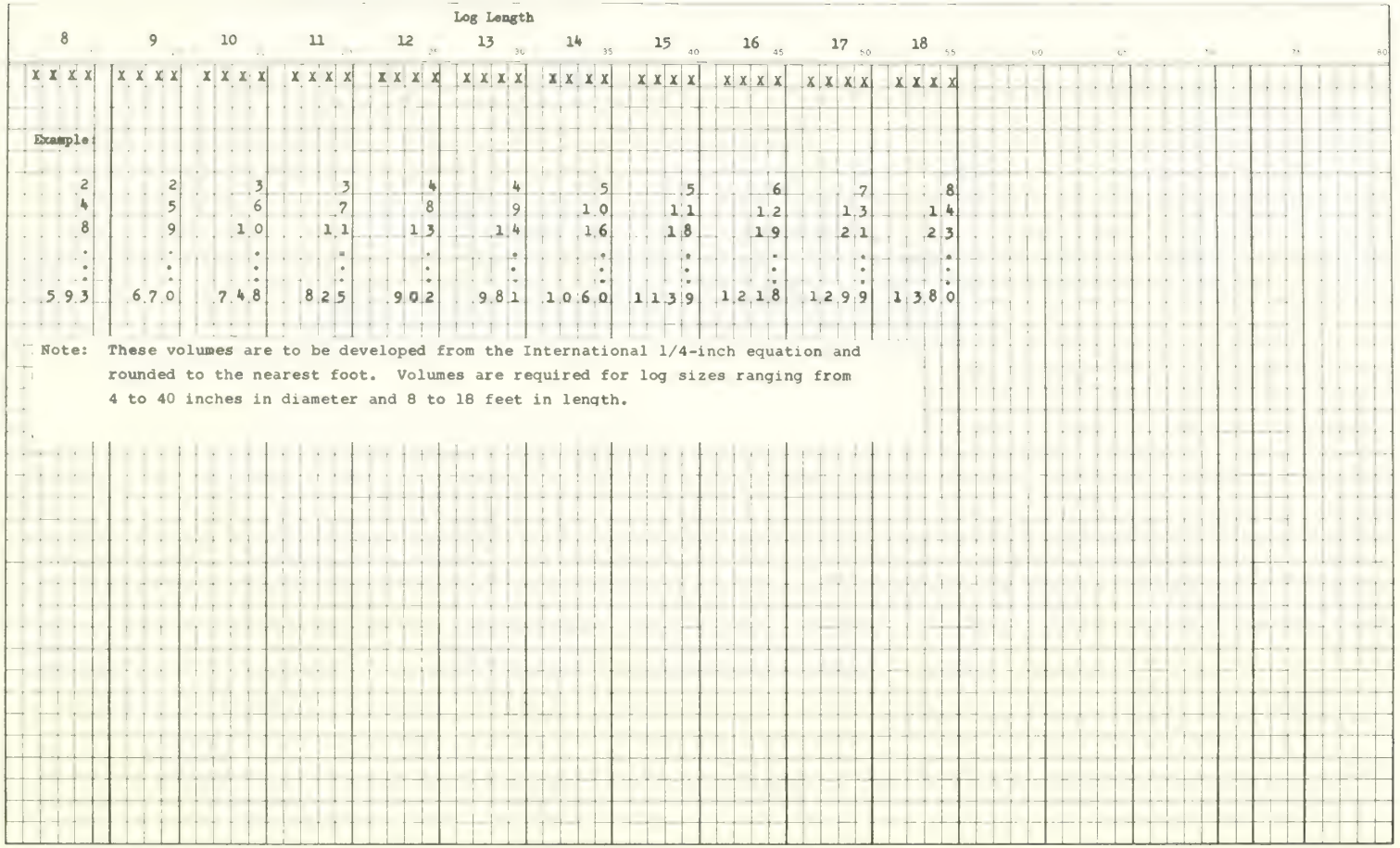
APPENDIX D

Data Location On Computer Cards

DATE
SHEET ___ OF ___
DATA RECORDED BY

COMPONENT NO. 2

International 1/4-inch Log Rule (2.1)



Note: These volumes are to be developed from the International 1/4-inch equation and rounded to the nearest foot. Volumes are required for log sizes ranging from 4 to 40 inches in diameter and 8 to 18 feet in length.

DATE _____
SHEET _____ OF _____

COMPONENT NO. 3
Converging Factors (2.2)

DATA RECORDED BY _____

Log Length

7	8	9	10	11	12	13	14	15	16
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
Example:									
1880	1626	1406	1238	1106	1000	901	819	751	694
1855	1607	1395	1233	1104	1000	904	824	758	701
1837	1593	1388	1229	1103	1000	906	828	763	707
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
1749	1527	1349	1208	1094	1000	918	849	789	737

Note: These are relative log scale factors based on the unrounded International 1/4-inch log rule. Factors are needed for log sizes ranging from 8 to 30 inches in diameter and 7 to 16 feet in length. The factors are recorded without the decimal point. A value of 1.880 is recorded as 1880.

DATE _____
SHEET ___ OF ___
DATA RECORDED BY _____

COMPONENT NO. 4
Expanding Factors (2.3)

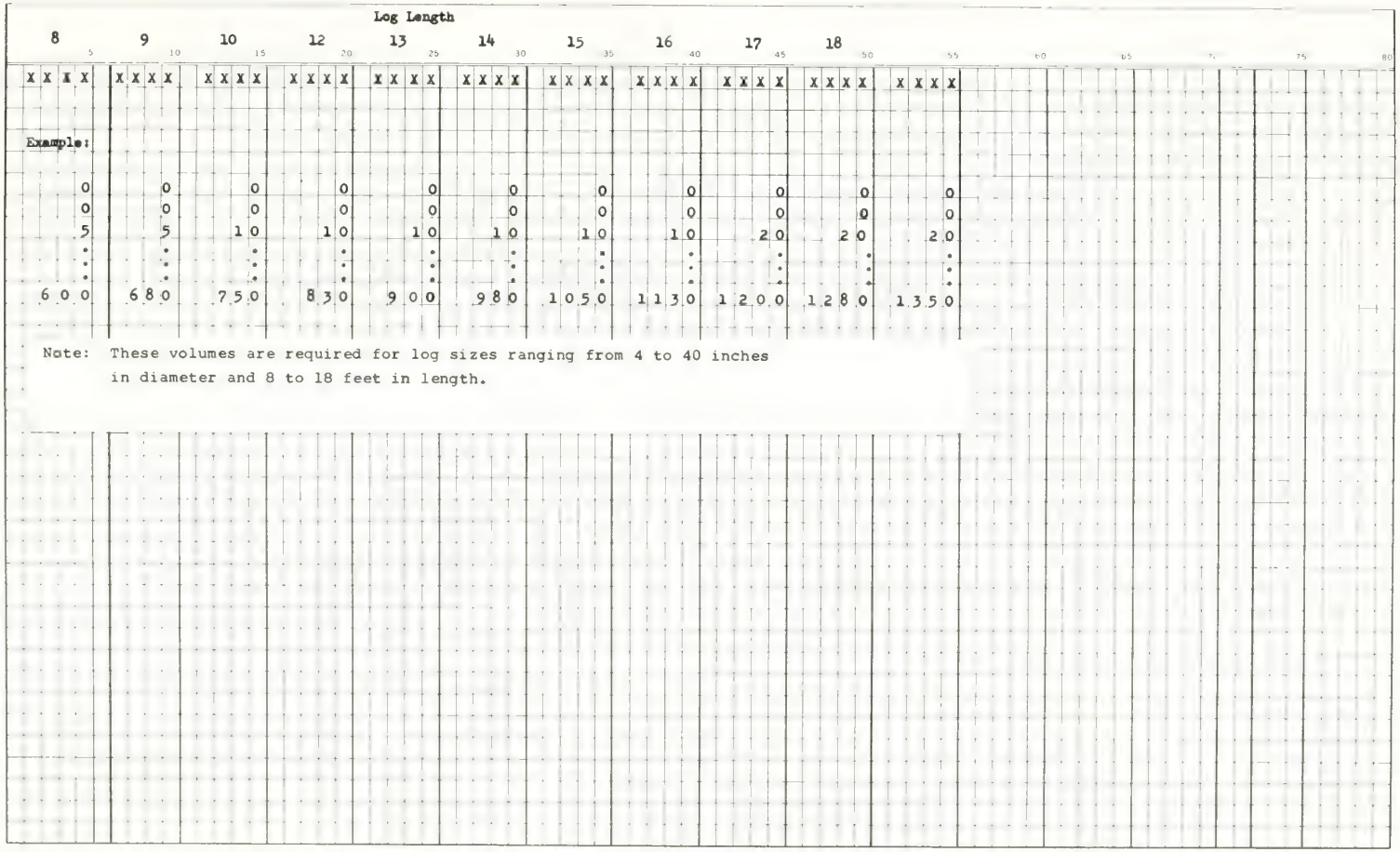
	Log Length				
	8	10	12	14	16
	XXXX	XXXX	XXXX	XXXX	XXXX
Example:					
	615	808	1000	1221	1442
	622	811	1000	1213	1426
	628	814	1000	1207	1414
	•	•	•	•	•
	•	•	•	•	•
	•	•	•	•	•
	655	828	1000	1178	1357

Note: These are relative log scale factors based on the unrounded International 1/4-inch log rule. Factors are needed for log sizes ranging from 8 to 30 inches in diameter and 8, 10, 12, 14, and 16 feet in length. The factors are recorded without the decimal point. A value of 0.615 is recorded as 615.

DATE _____
SHEET ___ OF _____
DATA RECORDED BY _____

COMPONENT NO. 5

Scribner Decimal C Log Rule (2.4)

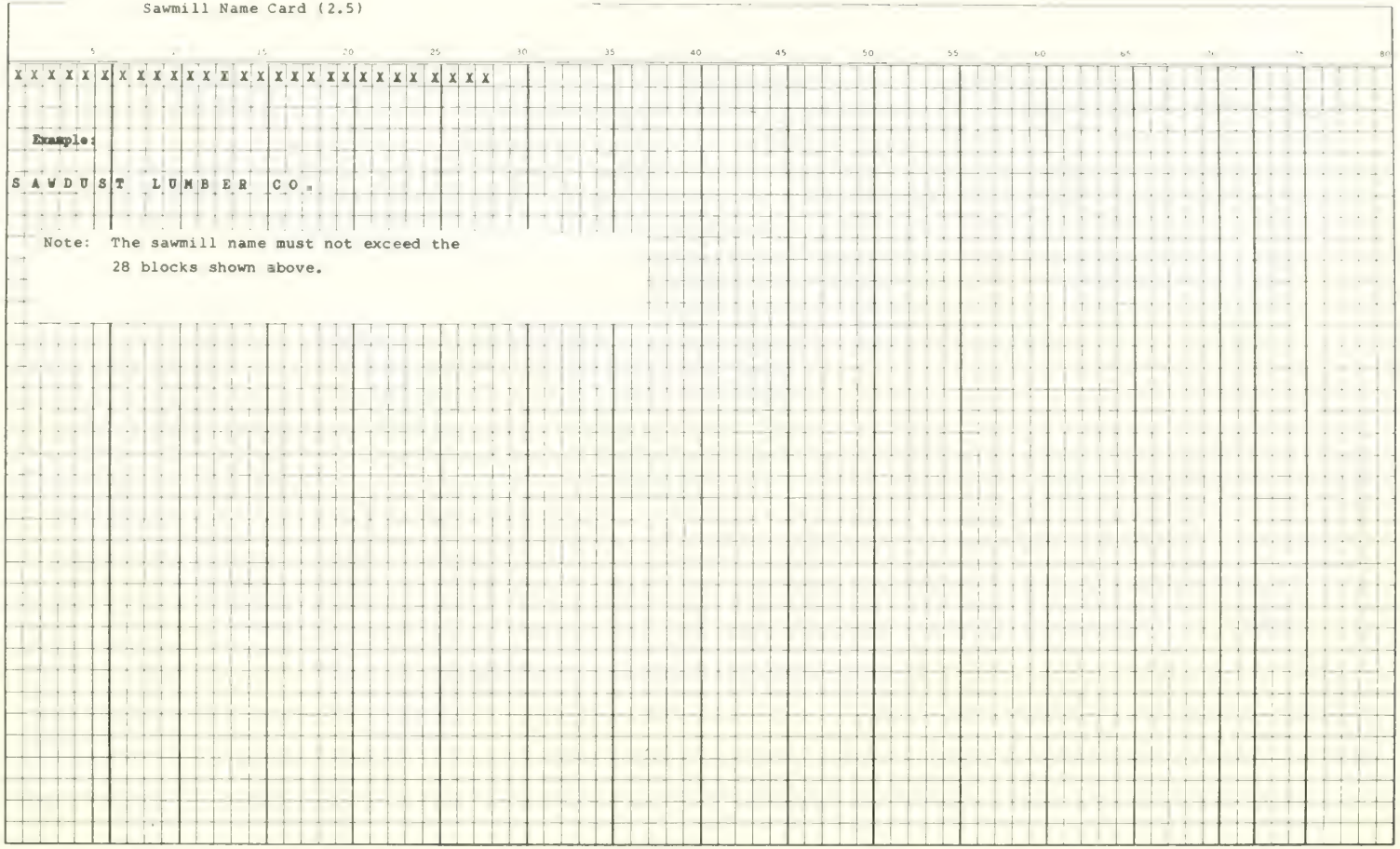


Note: These volumes are required for log sizes ranging from 4 to 40 inches in diameter and 8 to 18 feet in length.

DATE
SHEET OF
DATA RECORDED BY

COMPONENT NO. 6

Sawmill Name Card (2.5)



Note: The sawmill name must not exceed the 28 blocks shown above.

DATE

SHEET ____ OF ____

DATA RECORDED BY

COMPONENT NO. 7

Primary Data Card (2.6)

Month	Day	Year	Oper. Cost/ Minute	Chip Price/ Ton	Dunnage Price	Timbers Price	Profit %	Risk %	Broker %	Discount %	Productive Headsaw Time	Number Hours/ Day
XX	XX	XX	X.XX	X.XX	XX	XX	XX	XX	XX	XX	X.XX	X.XX
Example:												
1	3	70	2.50	6.50	60	85	10	10	5	2	7.00	8.00

Note: The user must place a value in each specified location even if the value is "0." Information found in Appendix E may aid the user in determining his correct operating cost per minute.

Productive headsaw time is the average number of hours that the headsaw is in operation during each day. For example, if on the average the headsaw is in operation 7 out of each 8 hours, the value entered on the primary data card would be 7.00. The computer uses the productive headsaw time to allow for normal downtime.

Under number of hours per day, enter the average number of hours the mill operates per day. For a mill working one 8-hour shift, the value would be 8.00.

COMPONENT NO. 8

Number of Species Card (2.7)

XXX

Example:

10

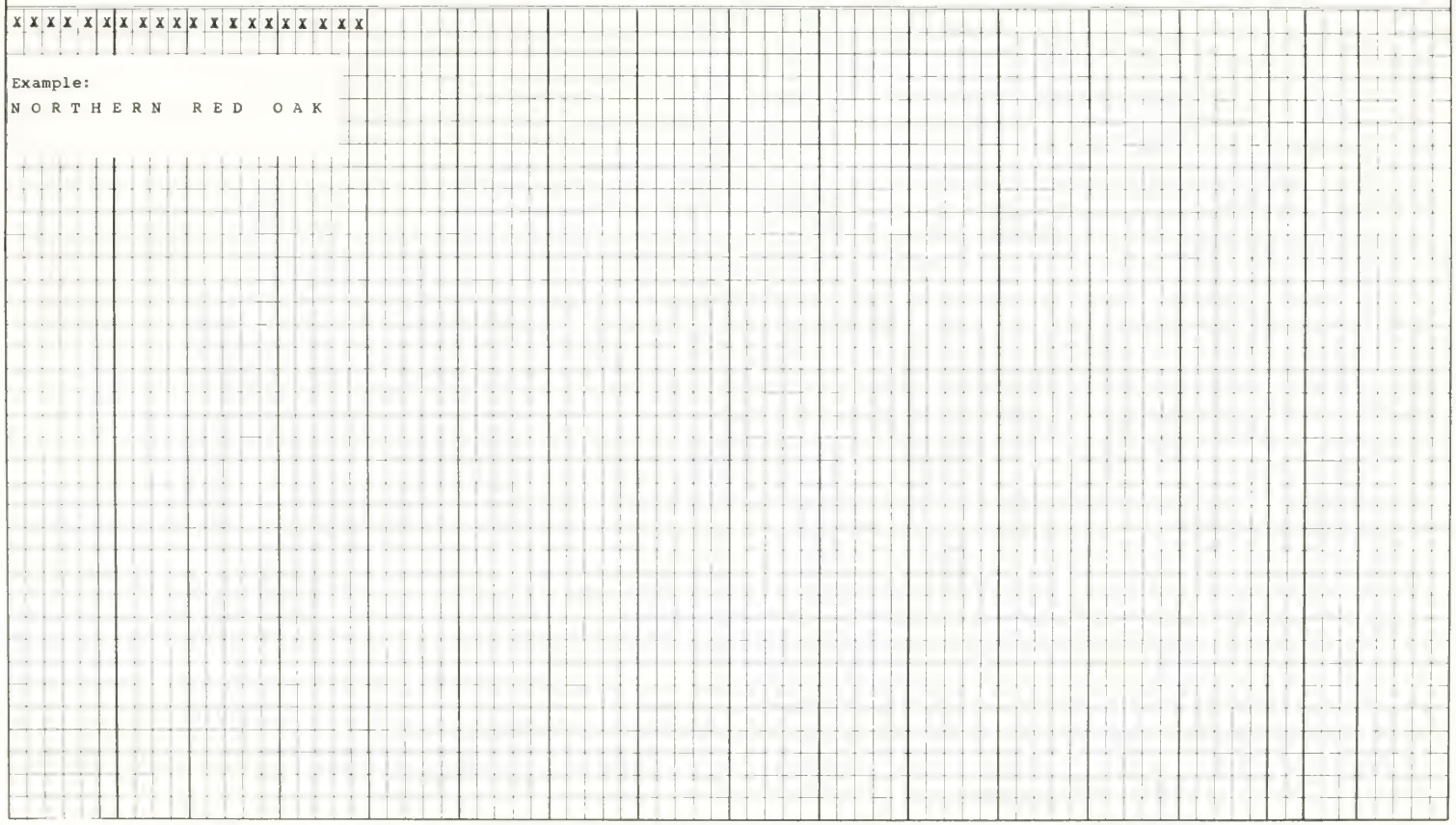
Note: If the user wishes to obtain log values for only three species, then he puts a 3 on this card. He must, however, remember to remove the data for the unwanted species before processing the deck through the computer.

DATE _____
SHEET ____ OF ____

DATA RECORDED BY _____

COMPONENT NO. 9

Species Name Card (2.8)



COMPONENT NO. 10

Lumber Prices (2.9)

DATE

SHEET ____ OF ____

DATA RECORDED BY

Species	Thickness	Lumber Grade: FAS	1F	SAP	#1C	#2C	#2A	#2B	SW	#3A	#3B	Timbers
XX	X	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	DDD	DDD	
	X	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	DDD	DDD	
	X	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	DDD	DDD	
	X	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	DDD	DDD	TTT
Example:												
RO	4	250	240		172	98				88		
	5	255	245		193	98				88		
	6	265	255		198	98				88		
	8	295	285		215	98				88		

Note: Values per MBF must be entered in the areas marked with "X's" for each lumber grade for which yields are shown in Component No. 14.

The areas marked with "D's" indicate that the user can put a price here, but if he does not, the dunnage values entered on the primary data card (Component No. 7) will be used by the computer.

The area marked with "T's" indicates that the user can put a price here, but if he does not, the timbers value entered on the primary data card (Component No. 7) will be used by the computer.

To eliminate the use of an extra card, the value for timbers is entered on the 8/4-inch thickness card.

DATE

SHEET OF

DATA RECORDED BY

COMPONENT NO. 13

Lumber Yield Control (2.12)

Species	Log Grade	Min. Diam.	Max. Diam.	Degrade Factor
XXXX	X	XX	XX	XXX
Example:				
WRO	1	13	25	100

Note: The degrade factor is recorded without the decimal point. A factor of 1.00 is recorded as 100. SOLVE uses the degrade factor to adjust lumber values for the degrade that occurs with the air drying of lumber. If the lumber yields are based on air-dry lumber or if degrade has already been accounted for, this factor is 1.00. However, if degrade has not been accounted for, the user must subtract a loss in percent of air-dry lumber value (as a decimal) from 1.00 to obtain a degrade factor. Recommended losses and resulting degrade factors are:[1/]

Species	Percent Loss	Degrade Factor
White oak and red oak	2.0	0.98
Yellow-poplar, basswood, cucumber	1.0	0.99
Maple and beech	3.0	0.97

[1/] Cuppett, D. G. How to determine seasoning degrade losses in sawmill lumber yards. USDA Forest Serv. Res. Note NE-32, 7 pp. NE. Forest Exp. Sta., Upper Darby, Pa. 1965.

COMPONENT NO. 12

Chip Yields Per MBF (2.11)

Species Ident.	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
XXXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Example:																		
MH	230	199	173	147	126	110	99	89	84	79	73	68	63	58	52	52	52	52

Note: The chip yields shown in the above example are for mixed hardwoods.[1/] These yields, in tons per MBF, are recorded without the decimal point. A value of 2.30 tons is recorded as 230.

[1/] Keppler, William E., Jr., and William E. Duggan. The mechanized portable sawmill--a key to higher productivity. North Carolina Agr. Ext. Serv., Misc. Ext. Publ. 41, 28 pp. Raleigh. 1968.

DATE
SHEET ____ OF ____
DATA RECORDED BY

COMPONENT NO. 13
Lumber Yield Control (2.12)

Species	Log Grade	Min. Diam.	Max. Diam.	Degrade Factor
XXX	X	XX	XX	XXX
Example:				
NRO	1	13	25	100

Note: The degrade factor is recorded without the decimal point. A factor of 1.00 is recorded as 100. SOLVE uses the degrade factor to adjust lumber values for the degrade that occurs with the air drying of lumber. If the lumber yields are based on air-dry lumber or if degrade has already been accounted for, this factor is 1.00. However, if degrade has not been accounted for, the user must subtract a loss in percent of air-dry lumber value (as a decimal) from 1.00 to obtain a degrade factor. Recommended losses and resulting degrade factors are:[1/]

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[1/] Cuppett, D. G. How to determine seasoning degrade losses in sawmill lumber yards. USDA Forest Serv. Res. Note NE-32, 7 pp. NE. Forest Exp. Sta., Upper Darby, Pa. 1965.

COMPONENT NO. 14

Lumber Yield by Grade (2.13)

	N	Log Diam.	Gross Int. 1/4 Volume	Lumber Tally	Lumber Grades FAS	1F	SAP	#1C	#2C	#2A	#2B	SW	#3A	#3B	TMBR
	X	XX	XXXX	XXXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Example:															
	12	13	1035	1091	225	150		249	192				171	12	
	17	14	1945	2040	252	130		321	163				111	22	
	18	15	2510	2551	255	149		275	212				87	21	
	1	25	340	375	440	61		211	160				43	85	

Note: The percent lumber yields by grade are recorded without decimal points.
A yield of 22.5 percent is recorded as 225.

DATE _____
SHEET ___ OF _____

COMPONENT NO. 15

Lumber Yield by Thickness (2.14)

DATA RECORDED BY _____

Species	Log Grade	Diameter	Thickness	Lumber Grades: FAS	1F	SAP	#1C	#2C	#2A	#2B	SW	#3A	#3B	Timbers
XX	X	XX	X	XXXX	XXXX	XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	
			X	XXXX	XXXX	XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	
			X	XXXX	XXXX	XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	
			X	XXXX	XXXX	XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	1000
Example:														
NRO	1	14	4	837	930	0	908	976	0	0	0	1000	1000	
			5	144	70	0	73	24	0	0	0	0	0	
			6	19	0	0	19	0	0	0	0	0	0	
			8	0	0	0	0	0	0	0	0	0	0	1000

Note: The percent lumber yields by thickness are recorded without decimal points.
A yield of 83.7 percent is recorded as 837.

COMPONENT NO. 16

Log Length Distribution (2.15)

Species	Log Grade	Log Length 8	10	12	14	16
XXX	X	XXX	XXX	XXX	XXX	XXX
Example:						
WRO	1	0	11	33	26	30

Note: These values are recorded as percents of the total by grade and species.

COMPONENT NO. 17

Log Diameter Distribution (2.16)

DATE _____

SHEET ___ OF _____

DATA RECORDED BY _____

Species	Log Grade	Log Scaling Diameter																							
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
XXX	X	XX	X X	XX	XX	XX	XX	X	X	XX	XX	XX	X	XX	XX	XX	XX	X	X	XX	XX	XX	X	X	
Example:																									
NRO	1	0	0	0	0	0	17	10	14	12	9	12	11	5	3	1	1	1	1	2	1	0	0	0	

Note: These values are recorded as percents of the total by grade and species.

APPENDIX E

Sawmill Operating Cost Per Minute

Calculation of Sawmill Operating Cost per Minute

The sawmill operating cost per minute is obtained by dividing the total yearly operating cost by the number of minutes the mill was in operation during the year. Both the yearly operating cost and the number of minutes in operation should be determined as accurately as possible. The following discussion should aid the user in these tasks.

Total yearly sawmill operating cost.—The total yearly cost must include all costs incurred by the sawmill from the yard to the air-dry lumber loaded for shipment. The following list is presented as an example of the factors that should be considered when determining this cost. This is only a sample list. It may not be the same for all mills.

Operating Costs

Sawmill[1]

Wages (lumber inspector)
Wages (manufacturing)
Supplies, repairs, maintenance
Power
FICA Tax
Employment security
Workmen's compensation
Depreciation

Lumber Yard

Salary (superintendent)
Salary (lumber inspector)
Wages (day laborers)
Supplies, repair, maintenance
Lumber stack foundations, sticks, straps, etc.
FICA tax
Employment security
Workmen's compensation
Depreciation

Administrative[2]

Salary (general manager)
Salaries (office)
Salaries (night watchmen)
FICA tax
Employment security
Workmen's compensation
Depreciation
Office supplies
Telephone
Advertising
Travel expense
Group insurance
Interest
Property taxes
Miscellaneous taxes

As can be seen by the above list, the total yearly cost does not include such factors as logging costs, lumber selling cost, log purchasing cost, or the cost of logs.

Sawmill yearly operation time in minutes.—The yearly operation time in minutes includes the total time that the sawmill was in operation during the year. For a sawmill that works one 8-hour shift per day, the maximum yearly operating time would be 124,800 minutes. If the sawmill closes for a week's vacation, this figure would be reduced by 2,400 minutes. A further reduction would be made for any abnormal downtime experienced by the mill.

[1]Includes cost of operating log yard and cost of producing chips.

[2]These costs must be prorated according to the sawmills proportionate share when other functions such as logging, log purchase, lumber selling, etc., are included in the administration costs.

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by David R. Houston

The use of large-scale aerial **COLOR PHOTOGRAPHY** for assessing **FOREST TREE DISEASES**

I. Basal Canker of White Pine: A Case Study

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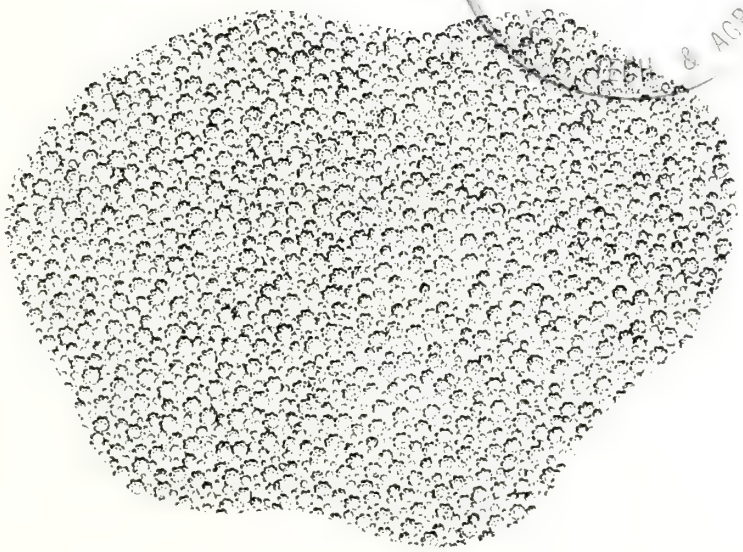

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-230
1972

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

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MANUSCRIPT RECEIVED FOR PUBLICATION 30 JULY 1971.

INTRODUCTION

OVER THE PAST decade, the use of aerial color photography as a tool for assessing damage to forest trees by insects and diseases has received increasing attention *(Ciesla et al. 1967, Heller et al. 1967, Meyer and French 1967, Murtha and Kippen 1969, Murtha and Harris 1970)*. Improvements in infrared color aerial film offered the possibility of extending visibility of tree foliage to wave lengths beyond those sensed by eye and gave added impetus to investigations on color photography for this purpose. Murtha *(1969)* has published an extensive bibliography on the subject.

In 1966, we began a study to determine the efficacy of using color infrared and true color aerial photography to assess the progressive development of basal canker of white pine. The symptomatology of this disease and the biotic and environmental factors contributing to its etiology and to patterns of its development were presented earlier *(Houston 1969)*.

Briefly, basal canker develops when bark-cankering fungi invade the lower stems of young pines through either lesions made by ants or wounds caused by snow and ice. Presence of the disease is associated with ant mounds and with topographic features that influence their occurrence or that contribute to the accumulation of snow and ice. Such features include depressions and swales, hedgerows, roadways, and rock piles.

This paper discusses the use of aerial color photography to discern symptoms of the disease as it developed over time, the factors contributing to disease development, and the patterns of disease development.

METHODS AND MATERIALS

Eight 0.2-acre plots (66 feet x 132 feet) established and mapped in 1965 or 1966 in 5- to 14-year-old plantations of white pine growing on the Tug Hill Plateau in north central New York were used in this photographic study. The plots, affected by basal canker, were selected to include diseased trees, ant mounds, and such topographic features as hedgerows, swales, and rock piles that were shown earlier to contribute to canker initiation *(Houston 1969)*.

The disease condition of each tree in these plots was noted annually and whenever the plots were photographed. The plot corners, and sometimes the plot centers, were marked with 6-foot lengths of white water-repellent paper. These markers delineated plots and provided a scale reference. Orange-colored plasticized fabric bags tied to poles that were attached to tree crowns helped to locate plots from the air and indicated direction of the flight line.

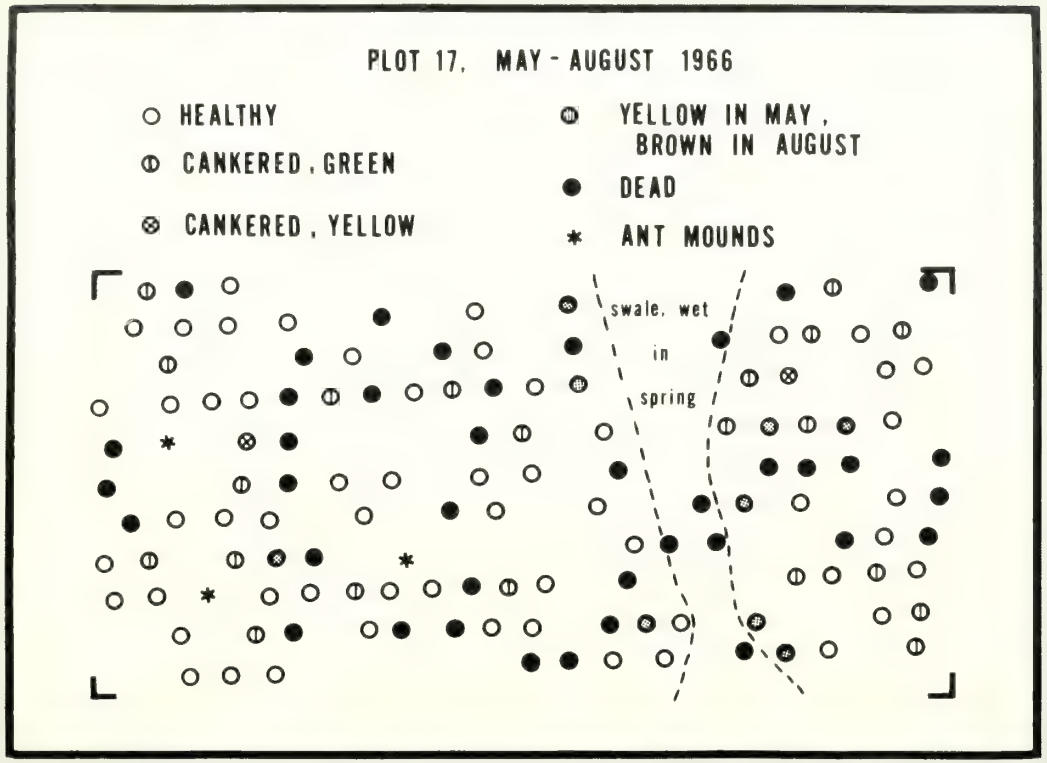
A Hulcher 70-mm. camera equipped with a 150-mm. focal-length lens was used to obtain stereo-sequenced photographs at scales of 1:792 (1 inch = 66 feet) to 1:1,584 (1 inch = 132 feet). True-color film (Kodak SO-282) was exposed at ASA 100 in May and August 1968, and Kodak 2442 was exposed in August 1970. Infrared color film—Kodak 8443 in May and August 1966 and 1968, and Kodak 2443 in August 1970—was exposed through a minus-blue filter (Wratten #12) at ASA 100. "Unaged" film was exposed also through an infrared attenuating filter (Corning #3966 X 0.5). Films were processed with a Morse rewind system, and the positive transparencies were examined stereoscopically. Tree conditions determined visually on films were compared with actual tree conditions on the ground.

RESULTS

Detection of Symptoms

Representative photography of two plots and ground-truth maps of them are presented in figures 1 to 8. Visible symptoms such as chlorotic or brown foliage, thin crowns, or bare branches could be seen readily at any of the scales used on both true-color (TC) and infrared (IR) films. Diseased trees sometimes appeared more striking on IR than on TC, but this usually was because of the unusual color combinations of IR film.

Figure 1.—Map of Plot 17, showing tree disease conditions in May and August 1966 and the locations of ant mounds and wet swale.



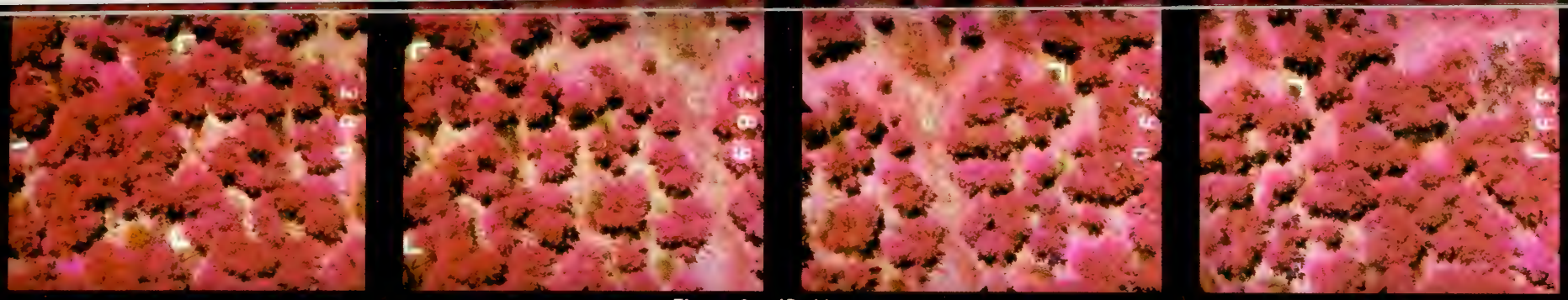


Figure 2.—IR, May 1966.

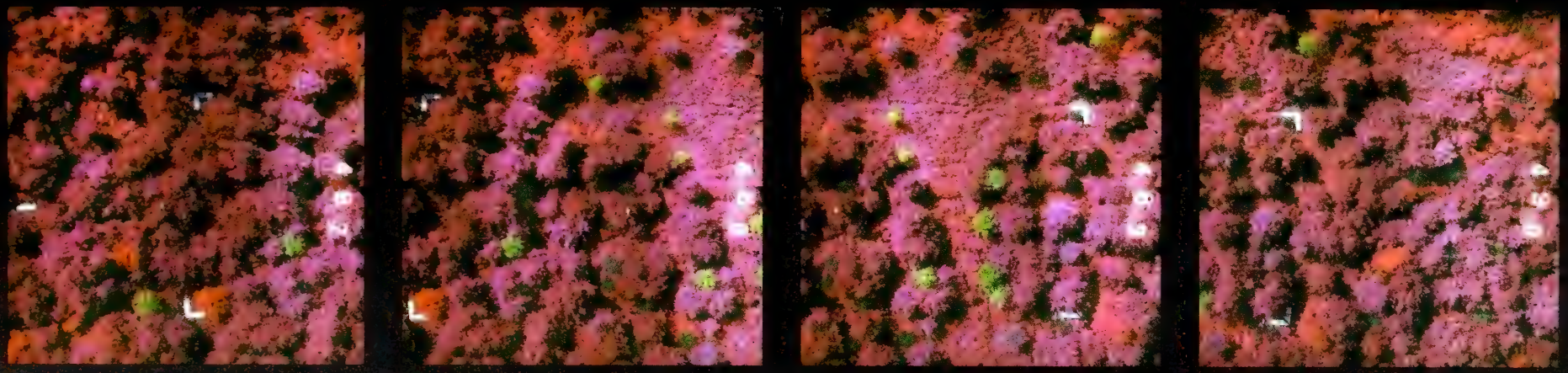


Figure 3.—IR, August 1966.

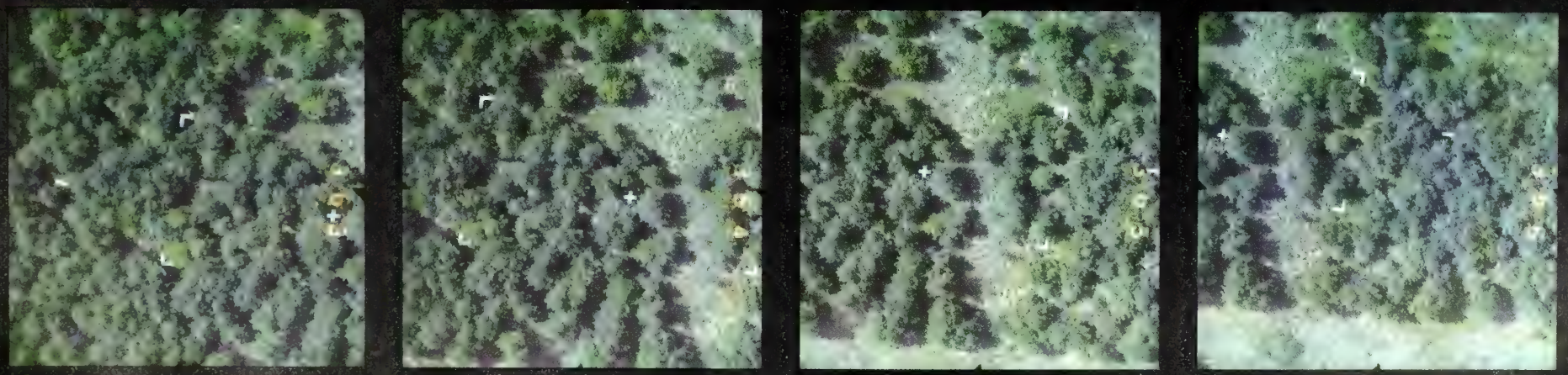
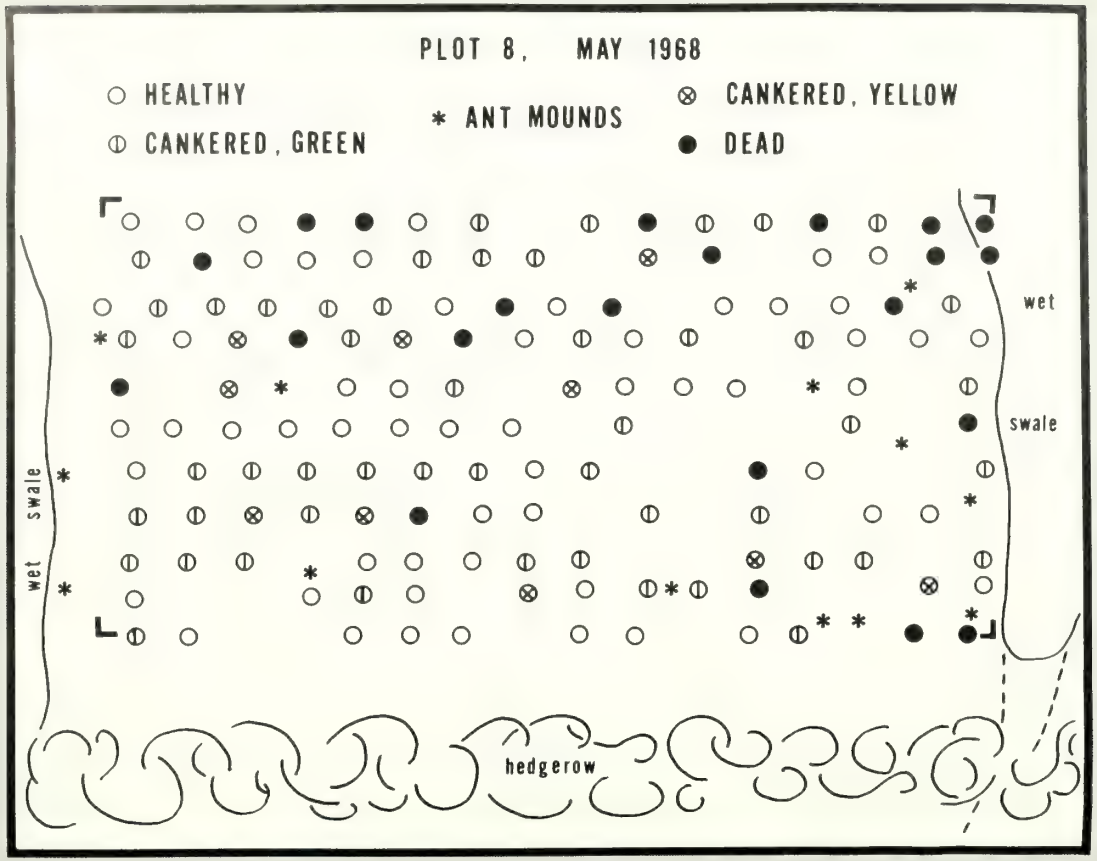


Figure 4.—TC, May 1968.

Figure 5.—Map of Plot 8, showing tree disease conditions in May 1968 and the locations of ant mounds, wet swales, and hedgerow.



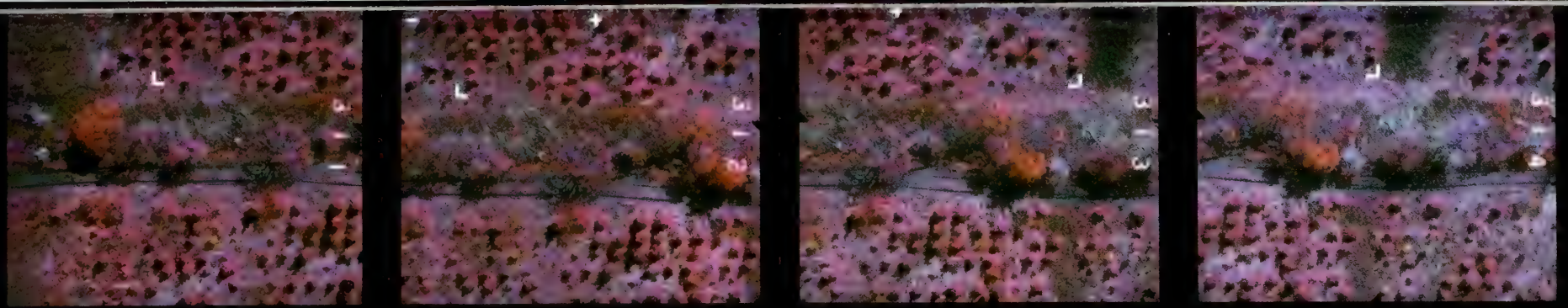


Figure 6.—IR, May.

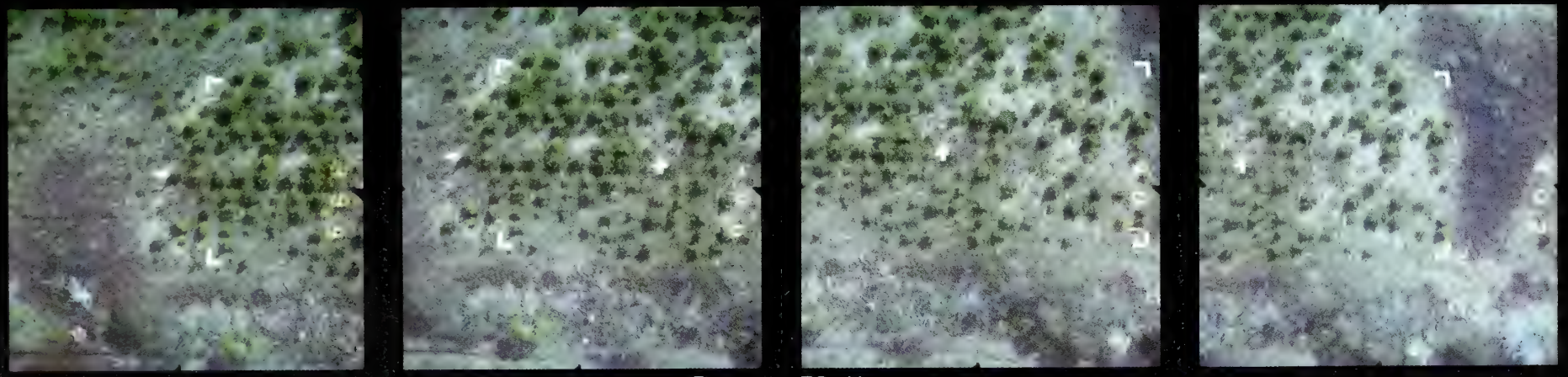


Figure 7.—TC, May.

Figure 8.—TC, August.

Table 1.—*Comparison between ground- and photo-determined tree disease condition of 57 trees (IR, August 1966, Plot 17).*

Item	Number of trees determined as—			
	Healthy	Green-cankered	Yelow-cankered	Brown
Ground	34	15	7	1
Film	29	20	7	1

There was no indication that previsible symptoms were revealed by IR photography. Indeed, it was difficult to distinguish accurately between healthy and "green-cankered" trees on the film (table 1). This difficulty is greater than shown by the figures in table 1: 13 of the 20 trees classed as green-cankered on the film actually were healthy, and 8 of 15 green trees with cankers were determined from the film to be healthy.

In general, as trees became progressively more diseased, they underwent foliar color changes from green (healthy) to yellow-green, to yellow, and finally to red-brown (figs. 4, 7, 8). On IR film, these changes were reflected as changes from shades of magenta (healthy) to mauve, pink, or light purple to gray-pink, and finally to yellow and yellow-green, respectively (figs. 2, 3, 6).

Although diseased trees sometimes were more obvious on photos taken in August than in May, most visible foliar symptoms were apparent on films exposed at either time. The IR photography (fig. 2) of May 1966 was fresh film (unaged); that of August 1966 (fig. 3) was the same but was exposed through an IR attenuating filter; and that of May 1968 (fig. 6) was the same film but was aged for 90 days at room temperature and was not exposed through the attenuating filter. Subtle differences in the amount of infrared reflectance from foliage, expressed as a variety of shades of magenta-mauve, were most apparent on the filtered or aged films.

Although foliar symptoms were readily visible on both spring and summer photography, other features were more apparent in the spring. Dead bare trees, standing or down, could be seen best prior to growth of grass and herbaceous weeds (figs. 2, 4, 6, 7). Some other features related to disease initiation and development also were most visible on spring photography.

Detection of Factors Related to Etiology and Disease Distribution

Large ant mounds of *Formica fusca* L. were most evident on TC and on IR photos taken in May before herbaceous growth occurred. Some ant mounds were distinguished by grass that had renewed its growth on the warmer, drier mounds sooner than on adjacent surrounding areas (figs. 6, 7). Tree damage around the ant mounds was visible as openings where trees had died and as dead and dying trees.

Hedgerows, rock piles, depressions, swales, and in many cases, openings devoid of trees, and dead and dying trees associated with such features, were readily detected by most of the photography. Permanently wet swales supporting marsh grasses or alders and willows were easily distinguished in May by dark-colored dead grass on both TC and IR films (figs. 6, 7). But in August, swales were more evident on IR film because of greater color contrasts between the foliage of conifers, hardwoods, and herbaceous plants.

Assessment of Disease Development over Time

Time-sequenced photography of specific plots or areas provided an accurate means of determining the rate of disease development within individual trees from the time their foliage turned color till they died. But photography did not reveal when trees became cankered initially nor the time that they remained cankered and green.

Repeated photography also revealed the patterns of disease development (more accurately, mortality) over time. These patterns varied between plots in different plantations and could be related to the presence of ant mounds and topographic features mentioned

earlier. In figures 2 to 4, disease development and mortality is associated with a slight depression that is wet early in the spring. In figures 6 to 8, tree mortality associated with a swale and with ant mounds can be seen.

DISCUSSIONS AND CONCLUSIONS

Although foliar symptoms were readily apparent on both TC and IR color transparencies, they often were more striking on the latter because of the sharper contrast between yellow and magenta than between red-brown and green. Another advantage of IR film not explored in this study may be the recording of small spectral changes in near infrared reflectance.

In the IR transparencies made from aged film or from fresh film exposed through an infrared attenuating filter, subtle differences were recorded for both healthy and green-cankered trees. Densitometric measurement of the cyan dye layer with a narrow-band-pass red filter might have allowed a more accurate separation of healthy trees and those cankered trees that were still green. Such a technique has shown promise for distinguishing nonsymptomatic red pine trees infected with *Fomes annosus* root rot *(Murtha and Kippen 1969)*.

This study showed the importance of choosing the proper time of year for photography. August photos often had more dead trees with red-brown foliage than did May photos. This was because most chlorotic trees died and turned brown during the summer. The red-brown dead needles dropped off during the winter. Thus, mid- to late-summer photography would seem best for assessing current mortality.

We gained a general impression that healthy and green-cankered trees photographed in August showed more variation in color and hue than they did when photographed in May. IR reflectance is influenced by needle age, and this may have been a factor. The youngest white pine foliage on Tug Hill is about a year old in May and is about 2 months old in August. Densitometry through narrow-band-pass filters might have verified our impressions.

Photos taken in May, however, were better than those made in August for distinguishing features associated with disease development. Herbaceous vegetation in summer obscured ant mounds, swales, and fallen dead trees that were readily visible in early spring.

Photos also provided an excellent tool for recording disease development. Permanent pictorial records in three-dimensional color permitted accurate reconstruction of tree mortality patterns and rates. Although these patterns and the stand features associated with them were already known for basal canker, the large-scale photographic record obtained in this study would have helped us to determine them more efficiently.

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The Rate of Value Increase for Black Cherry, Red Maple, and White Ash

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by Ted J. Grisez
and Joseph J. Mendel

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-231
1972

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

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MANUSCRIPT RECEIVED FOR PUBLICATION 16 NOVEMBER 1971

The Rate of Value Increase for Black Cherry, Red Maple, and White Ash

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UNDER the financial-maturity concept, trees are viewed as capital investments that should be liquidated when they fail to yield an acceptable rate of return. Thus trees or stands expected to exceed the minimum acceptable return—because of rapid volume growth or quality improvement—should be left to grow, while those expected to fall below the minimum acceptable return are financially mature, and should be harvested.

To determine whether or not a tree or stand is financially mature, it is necessary to estimate its present value and its expected value at some future date. The original value and the future value are then used to compute the compound interest rate of return.

In this paper we present the dollar values and value increases, as well as the rates of value increase, for three of the most important tree species of the Allegheny Plateau of New York and Pennsylvania: black cherry (*Prunus serotina Ehrh.*), red maple (*Acer rubrum* L.), and white ash (*Fraxinus americana* L.).

This is one of a series of papers presenting annual rates of value increase over a 10-year period for several important northeastern hardwood tree species. The reader who is interested in the details of the procedure for developing and computing the compound interest rates should refer to one of two earlier research papers (*Trimble and Mendel 1969, Mendel and Trimble 1969*). The same methods were used in this work.

DETERMINING THE RATE OF VALUE INCREASE

The rate of value increase, which is the cornerstone of the financial-maturity concept, is determined by three components: (1) the present value of the tree (V_o); (2) the prospective future value of the tree (V_n); and (3) the time period (10 years) considered between the determinations of present value and prospective value (n). From these data, the rate of value increase can be determined by solving for the rate of interest (r) in the compound interest formula:

$$(1 + r)^n = \frac{V_n}{V_o}$$

Present value.—Present value was computed by using lumber grade yields, price relatives, conversion costs, tree volumes, and lumber prices in a manner identical to that described in Research Papers NE-129 and NE-140.

The expected lumber grade yields were obtained for logs of the various species, sizes, and log grades. Data for red maple and white ash were obtained from unpublished reports, while those for black cherry are from Hanks (*1965*). Relative values (log-quality indexes) were then assigned to the logs of various species, sizes, and grades, using ratios of prices for each grade of lumber to the price of No. 1 Common (price relatives). These price relatives (table 1) were calculated from lumber prices reported in the HARDWOOD MARKET REPORT (*Lemsky 1962-66*). The log-quality indexes and log volumes were then used to calculate tree-quality index from felled-tree data for 140 black cherry, 156 red maple, and 111 white ash sample trees in northwestern Pennsylvania.

Once tree-quality indexes (tables 9 to 11) are established, the calculation of present value can be summarized as follows:

1. (Tree Q.I. $\times$ price for 4/4 No. 1 C/M) = gross value/M.
2. (Gross value/M $-$ conversion cost/M) = net value/M.
3. (Net value/M $\times$ volume in tree) = tree conversion value or present tree value.

The HARDWOOD MARKET REPORT of 6 January 1968 (*Lemsky 1968*) was used to obtain the prices of 4/4 No. 1 Common lumber. These prices were \$200/M board feet for black cherry, \$180 for red maple and \$134 for white ash. Conversion costs were the same as those listed in the research papers previously cited; these data

Table 1.—Lumber price relatives[1]

Species	Lumber grade					
	FAS	SEL	IC	2C	3A	3B
Black cherry	1.47	1.42	1.00	.48	.27	.25
Red maple	1.28	1.22	1.00	.46	.38	.29
White ash	1.57	1.49	1.00	.50	—	.36

[1] Based on 1962-66 *Hardwood Market Report* prices for Appalachian hardwoods (f.o.b. mills in the Johnson City, Tennessee, area), with 4/4 thickness plain-sawed No. 1 Common as the reference grade.

recognize that costs per unit volume are lower for large logs than for small ones. The Girard Form Class 81 volume table (*Mesavage and Girard 1946*) was used in the calculations.

Prospective future value.—Prospective value is the present value plus the increase in value due to diameter growth, increase in volume, and improvement in quality over the next 10 years. Any change in lumber prices or conversion costs would also affect future value; but for this purpose it was assumed that there would be no change.

To compute future value, 10-year diameter growth rates (tables 12 to 14) were applied to the trees in each 2-inch diameter class and each vigor class of each species. Besides increasing in diameter, the tree 10 years hence might improve in butt-log grade and merchantable height. Several possible combinations of butt-log quality and merchantable height were provided for by assuming either no change or an improvement in one or both of these factors. It was assumed that vigor class would remain the same during the next 10 years. Finally, the prospective value of each tree was determined in the same manner as the present value.

Ten-year diameter growth rates were computed from regression equations developed in a field study in the high plateau of northwestern Pennsylvania and adjacent parts of southwestern New York. Sawtimber stands were visited to collect sample tree data from 524 black cherry, 427 red maple, and 277 white ash trees from 12 to 30 inches d.b.h. Diameter growth during the past 10 years was measured from two increment cores on each tree. Bark thickness was measured to account for its increase, and tree vigor (*Trimble 1960*) was judged. There were practically no vigor 4 trees among sawtimber-sized trees, so no computations were made for them. Since it was not possible to collect growth data by site classes, site variation was reduced by limiting the sampling to northern hardwood types. The poorer sites in this area tend to be occupied by other types.

The assumptions regarding height growth over the next 10 years were similar to those used in the two research papers previously cited, but were less restrictive. The following log height increase limitations were set for computation purposes:

Present d.b.h. (inches)	*Tree height classes that will not increase in height in next 10 years (16-foot logs)*
22	1
24	1 and 1½
26	1, 1½, and 2
28	No increase for any tree 28 inches d.b.h. or larger

Maximum log height used in the computations was 64 feet for all species.

The following assumptions were made about changes in butt-log grade:

1. The maximum butt-log grade improvement in 10 years would be one grade class.
2. No butt-log grade improvement would be computed for any tree over 27 inches d.b.h.
3. No trees with butt-log grades poorer than 4 would be considered acceptable. They may be assumed to have no value-increase potential and a zero rate of return.
4. No trees above 15 inches d.b.h. with butt-log grade 4 would be considered acceptable. While such trees may have a small value increase, they would not normally be left in a managed stand.

The computation.—After the values for each combination of present and prospective tree

size and quality were determined, the rate of value increase was obtained by solving the compound-interest formula, using a 10-year time period. These computations were made for over 5,000 combinations of tree characteristics at the beginning and end of the 10-year period.

THE RATES OF VALUE INCREASE

The rate of value increase is affected by the diameter, merchantable height, and quality of the tree at the beginning of the 10-year period, and by the changes in these variables during the period. The rates of value increase are summarized and presented as a range of rates in tables 2 to 4.

Tree earning power is less for trees with larger diameters.—Small sawtimber trees generally have a high rate of value increase because of a low volume and value at the beginning of the period. On the other hand, large trees have greater initial values; so the percentage increases will be smaller, even though the increases in dollar value may be large. For example, a 12-inch grade 3, one-log, vigor-1 red maple may be expected to make a 15.2-percent value increase annually with no change in butt-log grade or height, while a 26-inch tree with otherwise similar characteristics may be expected to increase in value at a rate of only 2.7 percent. The actual dollar amounts of these increases, though, are $1.80 and $9.34 respectively (table 16).

Tree earning power increases markedly with increasing diameter growth rate.—Of two trees that are alike in all other respects, the tree with the faster growth rate will earn a higher rate of return. This is due to the greater accumulation of volume and improvement in inherent quality within a given butt-log grade. Since tree-vigor class estimates diameter growth rate, trees in the higher vigor classes will earn higher interest rates. For example, the rate of value increase for 16-inch, 2½-log white ash trees with butt-log grade 2 that do not increase in butt-log grade or merchantable height is 6.1 percent for vigor 1 trees, 4.8 percent for vigor 2 trees, and 3.2 percent for vigor 3 trees. The actual difference may be even greater because the more vigorous trees have a better chance of improving in grade and log height.

Trees with greater merchantable height usually have slightly higher earning power.—When there is no change in butt-log grade or merchantable height, the increase in earning power due to diameter growth alone is usually about ½ percent greater for 3-log, 16-inch trees of all species than for 1½-log trees. A 16-inch, grade-2, vigor-1 black cherry with 3 logs, for example, earns 6.2 percent interest while a similar tree with 1½ logs earns 5.6 percent interest. An exception is in butt-log grade 3 white ash trees, where the rate of value increase is less for trees that are taller at the start of the 10-year period.

Trees that have an increase in merchantable height have higher earning power.—Since upper logs in these species all have positive values,

Table 2.—Expected rate of value increase for black cherry trees[1]

[In percent]

D.b.h. (inches)	Due to growth only[2]			Due to growth and quality increase		
	Vigor 1	Vigor 2	Vigor 3	Vigor 1	Vigor 2	Vigor 3
14	7-11	5- 8	3- 5	8-38	6-32	4-29
16	5-11	4- 7	3- 6	6-16	5-13	4-11
18	5-10	3- 7	2- 6	5-15	4-11	3-10
20	4-10	3- 6	2- 6	5-14	4-10	3- 9
22	4- 8	3- 5	2- 5	4-11	3- 8	3- 8
24	3- 6	2- 4	2- 4	3- 9	3- 7	2- 6
26	3- 5	2- 4	2- 3	3- 7	2- 6	2- 6
28	2- 3	2	2	([3])	—	—
30	2- 3	2	2	—	—	—

[1] Based on 4/4 factory-grade lumber recovery. These rates can have a variation of 1 to 2 percent due to differences in location, volume estimates, and quality estimates.

[2] For butt-log grade 1 and 2 trees. Rates for grade-3 trees would be slightly higher.

[3] No quality improvement is assumed in trees larger than 27 inches d.b.h.

Table 3.—Expected rate of value increase for red maple trees[1]
[In percent]

D.b.h. (inches)	Due to growth only[2]			Due to growth and quality increase		
	Vigor 1	Vigor 2	Vigor 3	Vigor 1	Vigor 2	Vigor 3
14	7-11	6-10	5- 7	8-20	7-18	6-15
16	5-10	4-10	3- 6	7-16	6-15	5-12
18	4-10	4- 9	2- 6	6-14	5-13	4-10
20	4- 9	3- 9	2- 5	5-13	4-12	3- 8
22	3- 7	3- 5	2- 4	4-10	4- 8	2- 6
24	3- 6	2- 4	1- 3	4- 8	3- 6	2- 5
26	2- 5	2- 4	1- 2	3- 6	3- 5	2- 4
28	2- 3	2	1	([3])	—	—
30	2	2	1	—	—	—

[1] Based on 4/4 factory-grade lumber recovery. These rates can have a variation of 1 to 2 percent due to differences in location, volume estimates, and quality estimates.
[2] For butt-log grade 1 and 2 trees. Rates for grade-3 trees would be slightly higher.
[3] No quality improvement is assumed in trees larger than 27 inches d.b.h.

Table 4.—Expected rate of value increase for white ash trees[1]
[In percent]

D.b.h. (inches)	Due to growth only[2]			Due to growth and quality increase		
	Vigor 1	Vigor 2	Vigor 3	Vigor 1	Vigor 2	Vigor 3
14	7-12	6- 8	4- 6	3-25	4-23	2-20
16	5-11	4- 7	3- 6	3-58	2-53	0-51
18	4-10	3- 7	2- 6	4-31	3-27	1-26
20	4-10	3- 6	2- 5	4-25	3-21	2-20
22	3- 8	3- 5	2- 4	4-17	3-15	2-14
24	3- 6	2- 4	2- 3	4-14	3-13	2-12
26	3- 5	2- 3	1- 3	3-13	3-12	2-11
28	2- 3	2	1	([3])	—	—
30	2- 3	2	1	—	—	—

[1] Based on 4/4 factory-grade lumber recovery. These rates can have a variation of 1 to 2 percent due to differences in location, volume estimates, and quality estimates.
[2] For butt-log grade 1 and 2 trees. Rates for grade-3 trees would be slightly higher.
[3] No quality improvement is assumed in trees larger than 27 inches d.b.h.

those trees that increase in log height earn higher interest rates than those that do not. The difference usually amounts to 1 to 4 percent. A 16-inch, 2-log, vigor-1 black cherry with butt-log grade 1, for example, earns a 5.2-percent return without a height increase; with a 1-log height increase, the rate of value increase is 8.4 percent. Short trees that increase in height have a higher rate of value increase than tall trees having the same height increase because they have less value in the beginning.

Earning power is lower for trees with high initial quality.—Trees with butt-log grade 1 have a lower rate of value increase than similar trees with butt-log grade 2, and the rate for butt-log grade 2 trees is less than for grade 3. Using the 16-inch, 2-log, vigor-1 black cherries for an example again, those with butt-log grades 1, 2, and 3 have 5.2, 5.8, and 7.0 percent rates of value increase, respectively, if there is no change in merchantable height or butt-log grade. Even though the monetary gain of a low-grade tree is often less, the percentage gain in value will be higher because of its lower initial value.

Earning power is greatly increased by improvement in tree quality.—As trees develop, they may be expected to improve in quality.

The most important gains in quality are indicated by a step-up in butt-log grade. For example, a 20-inch, 2-log, vigor-2 black cherry tree with a grade 3 butt log that remains 2-log and grade-3 over the next decade earns 3.7 percent annually. Another tree, similar except that the grade-3 butt log becomes grade 2, has a 6.9-percent rate of return. To disregard quality when logs are sold has the same effect on earning power as the lack of quality improvement.

The probability of butt-log grade improvement decreases with increasing tree size. There may still be grade improvement in upper logs of large trees, however. An average rate if improvement in upper log grades is provided for in the equations used to compute tree-quality indexes.

There is also an improvement in log and tree quality due to increase in size within a given butt-log grade. In two logs of the same grade, or two trees of the same butt-log grade, the one with the larger diameter will, on the average, produce higher grade lumber. These gains in quality are also reflected by the log- and tree-quality indexes.

We have not considered the valuable veneer-grade black cherry logs, but it is apparent that trees with veneer butt logs would have a lower rate of value increase than butt-log grade 1 trees that are otherwise similar. Conversely, trees or stands that have logs coming into veneer grade would be earning very high rates of return.

A large proportion of white ash in the study area is used in the manufacture of baseball bats and tool handles. Such utilization may cause somewhat higher conversion values for white ash, with similar but less marked effects on rate of return as compared to cherry veneer.

TEN-YEAR VALUE INCREASE

The actual dollar increases in conversion value to be expected over a 10-year period are presented in tables 15 to 17. The increases in dollar value do not follow the same pattern as the rates of value increase.

Initial tree diameter has a strong positive effect on actual dollar increases—that is, trees with larger diameters at the beginning of the 10-year period have greater value increases than smaller ones. On the other hand, trees of larger diameters have lower rates of value increase than small trees.

Initial merchantable height has the same positive effect on 10-year value increase as it has on the rate of value increase, but it is much stronger. That is, the difference in earning power between tall and short trees is greater for dollar earnings than for rate of value increase; and this positive trend is more consistent—there are fewer exceptions.

And, like diameter, initial tree quality has a positive effect on 10-year value increase. High-quality trees accumulate more value than low-quality trees, when butt-log quality remains the same during the period. Unlike 10-year value increase, the rate of value increase is lower on high-quality trees than it is on poor ones.

The *changes* in diameter, height, and quality during the 10-year period under consideration have the same effect on dollar earnings as on the rate of value increase. Diameter growth, increases in merchantable height, and improvements in quality all increase earnings in proportion to their extent.

APPLICATION OF FINANCIAL MATURITY

According to the financial maturity concept, the rate of value increase is the criterion of financial maturity. When a tree or stand is expected to earn less than some minimum acceptable rate of return, that tree or stand should be harvested, and the money thus obtained should be invested in other trees or stands or in alternative investments where the minimum acceptable rate of return will be obtained. This is true regardless of the actual dollar increases involved.

For example, assume that a person growing timber must decide which of two stands should be clearcut. One stand, a little younger and smaller than the other, has a current value of $10,000 and is expected to increase in value by $8,800 over the next 10-year period, which amounts to a 6.5-percent rate of value increase. The other stand is somewhat older, has larger trees, and is currently worth $20,000; it is expected to increase $9,600 in value—a 4-percent interest rate.

If the owner can reinvest money where it will earn 5 percent interest, whether it is in timber-growing or in other investments, he may wish to cut the older stand and retain the younger stand for 10 or more years. For him, the 4-percent rate of value increase is not acceptable.

Although the older stand has a greater potential value increment ($9,600 vs. $8,800), the landowner will receive more income if he cuts the older stand and reinvests its value where he can obtain 5-percent interest. The value increase on this $20,000 reinvested at 5 percent would amount to $12,600 in 10 years, compared to $9,600 for the stand if left to grow.

Of course, there are other considerations to be made in cutting decisions, even where multiple uses are not important. The regulation of the cut, for instance, may alter decisions based on financial maturity if the land is being held for continuous production of timber. The costs or ease of regenerating a new stand might affect the comparison of financial returns.

Management practices outside the 10-year time period considered here frequently affect financial-maturity decisions. These data provide a guide to a limited question: Will I earn more over the next 10 years by cutting now, or by not cutting? Costs of growing the tree or stand to its present size are important, but have not been considered here. They are outside the scope of this paper. Neither have the costs or value increases to be expected by cutting 20 or more years from now been considered.

The latter consideration is especially important in the case of even-age management. In management practice, groups of trees are managed as a unit (stand). Intermediate cuttings or thinnings made in stands have the objective of increasing financial returns from the entire stand when evaluated over the period of an entire rotation. Trees are removed during thinnings on the basis of the effect this removal will have on the stand, not on the basis of their own individual financial maturity.

The rigid use of financial maturity as a criterion for which trees to cut in thinnings in typical Allegheny hardwood sawtimber stands would generally produce an undesirable effect on the stand. These stands have a strong component of intolerant species. If financial-maturity criteria are applied, the larger, more valuable trees (those with highest current value and therefore low expected rate of return) are removed. In an even-age stand, this leaves trees that are smaller, but the same age as those removed. The faster-growing trees are often the less-shade-tolerant species. Intermediate or suppressed trees of the intolerant species that are left seldom respond to the thinning with increased growth; in fact, some die. If such thinnings are repeated several times, the effect is a severe high-grading, which leaves poor-vigor intolerants and slower-growing tolerants. The overall financial returns from such a practice have never been evaluated, but they are far different from those to be expected under a more appropriate thinning regime.

For these reasons, the rate of value increase of individual trees should not be used as a criterion for marking in stands of intolerant species under even-age management. Trees to be retained in such intermediate cutting should be selected on some other basis, depending upon stand objectives. In general, leaving trees with the highest expected actual dollar increase will frequently satisfy the silvicultural objectives of the thinning.

The rate-of-value-increase tables (tables 2 to 4) are included in this paper to complete the series of financial maturity guides for northeastern species. They would be appropriate to use where these species occur as a minor component in stands of tolerant species being handled under uneven-age management. The user should recognize that cherry, ash, and red maple trees may not regenerate under uneven-age management, so that these species may gradually disappear from the stand.

DETERMINATION OF STAND FINANCIAL MATURITY

Since the three species that are included in this paper are normally managed under an even-age system, financial maturity data presented here will be most useful in the determination of *stand* rather than individual-tree financial maturity.

In earlier papers of this series on financial maturity of northeastern species, such as Research Papers NE-129 and NE-140 cited above, the detailed rates of value increase were used to determine diameters for financial maturity of each species at three different rates of return. These rates were presented for use in determining average rotation size in even-age stands.

We are including these tables of diameters for financial maturity (tables 5 to 7) to complete the series for possible use where cherry, red maple, or ash trees occur as a minor component of oak or yellow-poplar stands. The diameters listed in the tables are maximum diameters that will earn the indicated interest rate in the next 10 years if no butt-log grade improvement is expected. Smaller diameters

Table 5.—Black cherry d.b.h. for financial maturity, based on value increase determined by diameter growth rate alone on trees with butt-log grades 1 and 2

Vigor class	For return of—		
	2 percent	4 percent	6 percent
	Inches	*Inches*	*Inches*
1	30+	22	16
2	30	17	13
3	27	—	—

Table 6.—Red maple d.b.h. for financial maturity, based on value increase determined by diameter growth rate alone on trees with butt-log grades 1 and 2

Vigor class	For return of—		
	2 percent	4 percent	6 percent
	Inches	*Inches*	*Inches*
1	30+	22	16
2	30+	19	14
3	21	15	—

Table 7.—White ash d.b.h. for financial maturity, based on value increase determined by diameter growth rate alone on trees with butt-log grades 1 and 2

Vigor class	For return of—		
	2 percent	4 percent	6 percent
	Inches	*Inches*	*Inches*
1	30+	22	16
2	27	18	14
3	23	14	—

earn higher rates of interest; larger diameters earn lower rates. Where grade improvement is still occurring, the diameters would be larger than those given.

For this paper, however, we developed a more detailed method of determining the financial maturity of stands. The analysis of stand financial maturity may be made as follows:

1. Using an appropriate sampling technique, tally the sawtimber trees in fixed plots in the stand under consideration. The intensity of sampling will depend upon the area involved, the value of the timber, and the variability within the stand. Variable plots (plots measured with an angle gauge) are not recommended because large trees would be weighted too heavily—they are weighted by volume and value in our method. Data needed include: species, d.b.h. class, present butt-log grade, present merchantable height, vigor class, and the expected butt-log grade and merchantable height 10 years in the future.

2. With these data, record the present value and value increase of each sawtimber tree on the plots, as determined from tables 15 to 17.

3. Sum the present values and value increases and add the two sums to obtain expected future value. Then divide future value by present value.

4. The ratio obtained in step 3 may be used to determine rate of return for the stand by reference to a table of compound interest, such as that of Marty and Neebe (*1966*). An abbreviated compound interest table for a 10-year period is included here for field use:

Ratio $\frac{V_n}{V_o}$	*Rate (percent)*
1.22	2.0
1.28	2.5
1.34	3.0
1.41	3.5
1.48	4.0
1.55	4.5
1.63	5.0
1.71	5.5
1.79	6.0
1.88	6.5
1.97	7.0
2.06	7.5
2.16	8.0

A calculation representing an actual ¼-acre portion of a stand sample is shown in table 8. In actual practice it is not necessary to record all of the data shown in table 8. If present and future values are looked up in the field, it is necessary only to record the initial value and value increase for each tree. Nor is the rate of value increase column necessary. It is included merely to illustrate its inverse relation to value increase.

From the steps outlined above with the sample stand in table 8, the expected future value

Table 8.—Sample of a stand considered for clearcutting under even-age management

Species	D.b.h.	Butt log grade	Merchantable height	Vigor	Future grade	Future height	Initial value	Value increase	Rate of value increase
	Inches		*Feet*			*Feet*	*Dollars*	*Dollars*	*Percent*
Red maple	14	3	32	3	3	32	2.80	2.72	7.0
Red maple	20	1	56	2	1	56	40.24	16.82	3.6
Red maple	12	3	16	3	3	24	.58	1.49	13.6
Red maple	18	1	32	1	1	32	19.71	11.09	4.6
Red maple	14	3	32	1	2	40	2.80	9.97	16.4
Red maple	26	Cull	48	2	Cull	56	0	0	0
Red maple	20	2	48	1	1	48	30.24	25.13	6.2
Red maple	16	1	32	1	1	48	12.84	14.72	7.9
Red maple	14	2	32	2	1	40	5.71	8.93	9.9
Red maple	20	1	56	1	1	64	40.24	24.02	4.8
Black cherry	12	3	32	3	2	40	1.83	5.46	14.8
White ash	14	1	40	3	1	48	6.64	4.14	5.0
Red maple	12	3	16	3	3	24	.58	1.49	13.6
White ash	20	1	64	1	1	64	37.63	19.35	4.2
White ash	16	1	48	1	1	48	13.34	8.91	5.2
Red maple	16	3	48	2	3	48	7.78	6.78	6.5
Red maple	18	1	56	1	1	56	27.18	16.25	4.8
White ash	14	2	32	1	1	40	3.94	8.18	11.9
Red maple	12	4	16	1	3	32	0	3.55	∞
Total	—	—	—	—	—	—	254.08	189.00	—

is \$254.08 plus \$189.00, or \$443.08. The ratio V_n/V_o is \$443.08/\$254.08 = 1.74. Interpolation of the above tabulation shows that a ratio of 1.74 indicates a 5.7-percent rate of return for the stand.

Now, if a forest manager had chosen 6 percent as an acceptable rate of return, he might wish to clearcut this stand if rate of return is his sole criterion. If he has a large property and is regulating the cut to produce a balance of age classes, he should determine the rate of return on several of the most likely candidate stands. He would then select his required acreage for clearcutting from those stands with the lowest rates of return, other considerations being equal (likelihood of obtaining regeneration, etc.).

In this particular sample, there were no tree species other than the three included in this study. Normally a few others, such as beech or sugar maple, will be found—often in the smaller sizes. If there are only a few stems of other species, data for red maple may be used without incurring large errors.

Since these data apply to sawtimber trees only, it is not possible to include the present or future value of smaller trees in the calculations. As long as evaluations are restricted to predominantly sawtimber stands, this omission should have only a minor influence on the overall rate of return. Cordwood values of the 12 6-to 10-inch trees present in the previous example (table 8) could hardly exceed \$8 per acre, versus a value of \$1,016 for the sawtimber. Including this value and its expected increase would not change the expected rate of value increase by more than 0.1 percent.

One final caution is necessary in the use of the data presented in this paper. The values presented are accurate only for the conditions stated; changes in such things as lumber prices, conversion costs, and growth rates would affect the values. Individual managers could obtain more accurate information by recalculating the values, using data appropriate to their own operations. The calculations can be handled by electronic computer, and this procedure is recommended for owners having comparatively large areas under management.

Data for several other species can be developed by using log-quality index tables (*Mendel and Smith 1970*), upper-log grade relationships, and other appropriate data. Details of the methods used were presented in the USDA Forest Service Research Papers NE-129 and NE-140, previously cited.

For those who cannot recalculate the values for themselves, the data presented here may be used directly if the conditions are reasonably similar to those assumed. The stand rates of value increase calculated may not be precise, but the relative rates of two stands thus calculated should still provide a good guide as to which should be harvested first.

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TREE QUALITY INDEXES

Table 9.—Tree quality index, black cherry

Tree d.b.h. (inches)	Merchantable height to an 8-inch d.i.b. top, in feet						
	16	24	32	40	48	56	64
			BUTT-LOG GRADE 1				
16.0	0.847	0.845	0.843	0.841	0.840	0.838	0.836
18.0	.896	.894	.893	.891	.889	.887	.886
20.0	.946	.944	.942	.940	.939	.937	.935
22.0	.995	.993	.991	.990	.988	.986	.985
24.0	1.045	1.043	1.041	1.039	1.038	1.036	1.034
26.0	1.094	1.092	1.091	1.089	1.087	1.085	1.083
28.0	1.143	1.142	1.140	1.138	1.136	1.135	1.133
30.0	1.193	1.191	1.189	1.188	1.186	1.184	1.182
32.0	1.242	1.241	1.239	1.237	1.235	1.234	1.232
			BUTT-LOG GRADE 2				
14.0	0.742	0.715	0.687	0.660	0.633	0.606	.578
16.0	.796	.769	.742	.715	.687	.660	.633
18.0	.851	.824	.797	.769	.742	.715	.687
20.0	.906	.878	.851	.824	.797	.769	.742
22.0	.960	.933	.906	.878	.851	.824	.797
24.0	1.015	.988	.960	.933	.906	.878	.851
26.0	1.069	1.042	1.015	.988	.960	.933	.906
28.0	1.124	1.097	1.069	1.042	1.015	.988	.960
30.0	1.179	1.151	1.124	1.097	1.069	1.042	1.015
32.0	1.233	1.206	1.179	1.151	1.124	1.097	1.069
			BUTT-LOG GRADE 3				
12.0	0.510	0.498	0.486	0.474	0.462	0.450	0.438
14.0	.561	.549	.537	.525	.513	.501	.489
16.0	.613	.601	.589	.577	.565	.553	.541
18.0	.664	.652	.640	.628	.616	.604	.592
20.0	.715	.703	.691	.679	.667	.655	.643
22.0	.767	.755	.743	.731	.719	.707	.695
24.0	.818	.806	.794	.782	.770	.758	.746
26.0	.870	.858	.846	.834	.822	.810	.798
28.0	.921	.909	.897	.885	.873	.861	.849
30.0	.972	.960	.948	.936	.924	.912	.900
32.0	1.024	1.012	1.000	.988	.976	.964	.952

Table 10.—Tree quality index, red maple

Tree d.b.h. (inches)	Merchantable height to an 8-inch d.i.b. top, in feet						
	16	24	32	40	48	56	64
	BUTT-LOG GRADE 1						
16.0	0.772	0.761	0.751	0.741	0.731	0.721	0.711
18.0	.813	.803	.793	.783	.773	.762	.752
20.0	.854	.844	.834	.824	.814	.804	.794
22.0	.895	.885	.875	.865	.855	.845	.835
24.0	.937	.927	.917	.906	.896	.886	.876
26.0	.978	.968	.958	.948	.938	.928	.918
28.0	1.019	1.009	.999	.989	.979	.969	.959
30.0	1.061	1.051	1.040	1.030	1.020	1.010	1.000
32.0	1.102	1.092	1.082	1.072	1.062	1.052	1.041
	BUTT-LOG GRADE 2						
14.0	0.676	0.655	0.634	0.613	0.593	0.572	0.551
16.0	.719	.699	.678	.657	.636	.615	.595
18.0	.763	.742	.722	.701	.680	.659	.638
20.0	.807	.786	.765	.744	.724	.703	.682
22.0	.850	.830	.809	.788	.767	.746	.726
24.0	.894	.873	.852	.832	.811	.790	.769
26.0	.938	.917	.896	.875	.854	.834	.813
28.0	.981	.961	.940	.919	.898	.877	.857
30.0	1.025	1.004	.983	.963	.942	.921	.900
32.0	1.069	1.048	1.027	1.006	985	.965	.944
	BUTT-LOG GRADE 3						
12.0	0.491	0.483	0.475	0.467	0.459	0.451	0.443
14.0	.538	.530	.522	.514	.506	.498	.490
16.0	.584	.576	.568	.560	.552	.544	.536
18.0	.631	.623	.615	.607	.599	.591	.583
20.0	.677	.669	.661	.653	.645	.637	.629
22.0	.724	.716	.708	.700	.692	.684	.676
24.0	.770	.762	.754	.746	.738	.730	.722
26.0	.817	.809	.801	.793	.785	.777	.769
28.0	.863	.855	.847	.839	.831	.823	.815
30.0	.909	.901	.893	.885	.877	.869	.861
32.0	.956	.948	.940	.932	.924	.916	.908

Table 11.—Tree quality index, white ash

Tree d.b.h. (inches)	Merchantable height to an 8-inch d.i.b. top, in feet						
	16	24	32	40	48	56	64
			BUTT-LOG GRADE 1				
14.0	0.868	0.863	0.858	0.853	0.847	0.842	0.837
16.0	.919	.914	.909	.904	.899	.894	.888
18.0	.970	.965	.960	.955	.950	.945	.940
20.0	1.021	1.016	1.011	1.006	1.001	.996	.991
22.0	1.072	1.067	1.062	1.057	1.052	1.047	1.042
24.0	1.123	1.118	1.113	1.108	1.103	1.098	1.093
26.0	1.174	1.169	1.164	1.159	1.154	1.149	1.144
28.0	1.225	1.220	1.215	1.210	1.205	1.200	1.195
30.0	1.276	1.271	1.266	1.261	1.256	1.251	1.246
32.0	1.327	1.322	1.317	1.312	1.307	1.302	1.297
			BUTT-LOG GRADE 2				
12.0	0.729	0.717	0.705	0.692	0.680	0.668	0.656
14.0	.785	.773	.760	.748	.736	.724	.711
16.0	.840	.828	.816	.804	.791	.779	.767
18.0	.896	.884	.871	.859	.847	.835	.822
20.0	.951	.939	.927	.915	.903	.890	.878
22.0	1.007	.995	.983	.970	.958	.946	.934
24.0	1.063	1.050	1.038	1.026	1.014	1.001	.989
26.0	1.118	1.106	1.094	1.082	1.069	1.057	1.045
28.0	1.174	1.162	1.149	1.137	1.125	1.113	1.100
30.0	1.229	1.217	1.205	1.193	1.180	1.168	1.156
32.0	1.285	1.273	1.260	1.248	1.236	1.224	1.212
			BUTT-LOG GRADE 3				
12.0	0.473	0.527	0.580	0.633	0.687	0.740	0.793
14.0	.503	.556	.609	.662	.716	.769	.822
16.0	.532	.585	.638	.692	.745	.798	.851
18.0	.561	.614	.667	.721	.774	.827	.881
20.0	.590	.643	.697	.750	.803	.856	.910
22.0	.619	.673	.726	.779	.832	.886	.939
24.0	.648	.702	.755	.808	.862	.915	.968
26.0	.678	.731	.784	.837	.891	.944	.997
28.0	.707	.760	.813	.867	.920	.973	1.026
30.0	.736	.789	.842	.896	.949	1.002	1.056
32.0	.765	.818	.872	.925	.978	1.031	1.085

DIAMETER GROWTH RATES

Table 12.—Ten-year d.b.h. growth for black cherry, in inches

D.b.h.	Vigor 1	Vigor 2	Vigor 3
12	2.7	1.9	1.1
14	2.7	1.9	1.2
16	2.6	1.9	1.2
18	2.6	1.9	1.3
20	2.6	1.9	1.4
22	2.6	1.9	1.5
24	2.5	1.9	1.6
26	2.5	1.9	1.7
28	2.5	1.9	1.8
30	2.4	1.9	1.8

Table 13.—Ten-year d.b.h. growth rate for red maple, in inches

D.b.h.	Vigor 1	Vigor 2	Vigor 3
12	2.5	2.0	1.7
14	2.5	2.0	1.6
16	2.4	2.0	1.5
18	2.4	2.0	1.3
20	2.4	2.0	1.2
22	2.3	2.0	1.1
24	2.3	1.9	.9
26	2.2	1.9	.8
28	2.2	1.9	.7
30	2.2	1.9	.5

Table 14.—Ten-year d.b.h. growth rate for white ash, in inches

D.b.h.	Vigor 1	Vigor 2	Vigor 3
12	2.0	1.7	1.1
14	2.1	1.7	1.1
16	2.2	1.7	1.1
18	2.2	1.7	1.1
20	2.3	1.7	1.1
22	2.3	1.7	1.2
24	2.4	1.7	1.2
26	2.4	1.7	1.2
28	2.5	1.7	1.2
30	2.5	1.7	1.2

VIGOR CLASSES

Vigor 1.—A tree with a large, healthy, full crown in a dominant or codominant position. Half or more of the crown is exposed to direct sunlight. The crown is dense, with no evidence of disease or injury. Crown condition and position are more important than total length.

Vigor 2.—A tree with a fair-sized crown in a codominant position. Less than half the crown is exposed to direct sunlight. The crown is less dense and not so perfect as that of a Vigor 1 tree. This class may also include large-crowned trees that fail to meet the requirements of Vigor 1 because of mechanical injury or dying limbs.

Vigor 3.—A tree with a medium to small crown, usually in an intermediate position. Only the tip is exposed to direct sunlight. The crown may be open, with some dead or broken limbs, or thinly foliated. This class also includes trees with fair to large crowns in a codominant position that cannot meet the requirements for a Vigor 2 tree.

Vigor 4.—Usually a tree with a small crown in an overtopped position. This class includes all living trees that fail to meet the requirements of higher vigor classes.

Table 15.—Ten-year value increase for black cherry, in dollars

D.b.h. (inches)	Butt-log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	3.52	4.09	6.00	7.56	5.12	8.05	10.94	2.62	4.06	—	3.56	5.88	—	1.38	2.58	—	2.22	4.23	—
		24	4.25	5.27	6.82	7.64	7.31	10.21	12.56	3.33	4.58	—	5.14	7.61	—	1.84	2.71	—	3.49	5.40	—
		32	4.77	6.30	7.12	7.70	9.69	12.04	14.45	4.06	4.54	—	7.09	8.57	—	2.19	2.53	—	4.88	6.39	—
12	2	40	4.86	7.03	7.61	7.36	11.95	14.36	15.87	4.45	4.73	—	8.78	10.63	—	2.44	2.51	—	6.30	7.72	—
		48	4.78	7.68	7.44	7.03	14.44	15.95	17.54	4.81	4.52	—	10.71	11.96	—	2.59	2.21	—	7.79	8.73	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	1.39	2.73	3.84	4.79	6.22	8.13	9.69	1.72	2.49	—	4.75	6.19	—	.89	1.46	—	3.51	4.71	—
		24	1.66	3.57	4.52	5.09	7.86	9.42	10.23	2.22	2.92	—	5.92	7.17	—	1.19	1.61	—	4.44	5.30	—
		32	1.83	4.34	4.92	5.40	9.24	10.06	10.63	2.74	3.06	—	7.00	7.47	—	1.44	1.62	—	5.13	5.46	—
12	3	40	1.83	4.92	5.40	5.43	10.06	10.63	10.39	3.06	3.30	—	7.47	7.76	—	1.62	1.69	—	5.46	5.54	—
		48	1.76	5.47	5.51	5.49	10.71	10.46	10.06	3.37	3.32	—	7.83	7.55	—	1.76	1.62	—	5.61	5.24	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.07	.61	.84	1.08	4.05	5.16	6.11	.37	.52	—	3.04	3.81	—	.19	.28	—	2.21	2.78	—
		24	.09	.82	1.05	1.24	5.14	6.08	6.66	.50	.66	—	3.79	4.48	—	.26	.35	—	2.76	3.18	—
		32	.12	1.03	1.22	1.42	6.06	6.64	7.12	.63	.75	—	4.46	4.78	—	.33	.40	—	3.16	3.34	—
12	4	40	.13	1.20	1.40	1.53	6.62	7.10	7.13	.73	.86	—	4.76	5.00	—	.38	.45	—	3.32	3.39	—
		48	.15	1.38	1.51	1.65	7.08	7.12	7.10	.84	.92	—	4.98	4.93	—	.43	.48	—	3.37	3.23	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	6.28	5.74	9.05	11.88	6.97	11.60	16.20	3.81	6.51	—	4.96	8.85	—	2.28	4.52	—	3.36	6.68	—
		24	7.80	7.53	10.36	12.22	10.08	14.68	18.63	4.99	7.25	—	7.33	11.19	—	2.99	4.84	—	5.16	8.45	—
		32	9.07	9.09	10.96	12.33	13.41	17.36	21.18	5.98	7.45	—	9.92	13.27	—	3.57	4.62	—	7.19	9.90	—
14	2	40	9.60	10.42	11.79	12.07	16.83	20.65	23.41	6.91	7.79	—	12.73	15.76	—	4.08	4.80	—	9.36	12.06	—
		48	9.89	11.51	11.79	11.83	20.36	23.13	25.98	7.51	7.61	—	15.47	17.80	—	4.51	4.40	—	11.77	13.62	—
		56	9.60	12.08	12.12	—	23.42	26.27	—	7.90	7.74	—	18.09	20.40	—	4.70	4.41	—	13.91	15.83	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	3.21	4.11	6.29	8.25	8.81	12.12	14.95	2.69	4.39	—	6.88	9.58	—	1.59	2.94	—	5.35	7.59	—
		24	4.03	5.47	7.43	8.88	11.30	14.13	16.00	3.57	5.08	—	8.76	11.02	—	2.11	3.29	—	6.76	8.61	—
		32	4.75	6.72	8.16	9.37	13.42	15.28	16.65	4.36	5.46	—	10.30	11.77	—	2.57	3.33	—	7.89	8.94	—
14	3	40	5.10	7.80	9.01	9.59	14.93	16.30	16.58	5.10	5.90	—	11.41	12.29	—	2.98	3.59	—	8.58	9.30	—
		48	5.35	8.77	9.34	9.82	16.05	16.33	16.37	5.65	6.03	—	12.05	12.15	—	3.35	3.51	—	9.05	8.95	—
		56	5.31	9.38	9.86	—	16.37	16.41	—	6.06	6.31	—	12.20	12.03	—	3.55	3.65	—	8.99	8.70	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	0.47	0.99	1.51	2.03	6.85	9.03	10.99	0.64	1.03	—	5.43	7.13	—	0.38	0.67	—	4.33	5.68	—
		24	.63	1.35	1.87	2.31	8.87	10.83	12.28	.87	1.26	—	6.97	8.48	—	.51	.81	—	5.52	6.69	—
		32	.79	1.70	2.15	2.59	10.67	12.12	13.33	1.10	1.44	—	8.32	9.41	—	.64	.89	—	6.53	7.29	—
14	4	40	.92	2.02	2.46	2.78	11.99	13.20	13.77	1.31	1.62	—	9.28	10.08	—	.76	1.01	—	7.16	7.78	—
		48	1.05	2.33	2.65	2.99	13.07	13.64	14.12	1.49	1.74	—	9.96	10.32	—	.88	1.05	—	7.65	7.82	—
		56	1.13	2.57	2.90	—	13.56	14.04	—	1.65	1.89	—	10.23	10.48	—	.96	1.14	—	7.73	7.82	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	11.42	7.31	14.19	20.91	—	—	—	5.05	11.06	—	—	—	—	3.14	8.36	—	—	—	—
		24	15.44	10.17	16.89	22.51	—	—	—	7.06	12.93	—	—	—	—	4.35	9.43	—	—	—	—
		32	19.42	12.90	18.53	24.12	—	—	—	8.94	13.88	—	—	—	—	5.44	9.74	—	—	—	—
16	1	40	22.69	15.26	20.85	25.01	—	—	—	10.61	15.41	—	—	—	—	6.46	10.73	—	—	—	—
		48	25.94	17.60	21.76	26.01	—	—	—	12.16	15.82	—	—	—	—	7.49	10.66	—	—	—	—
		56	28.29	19.42	23.67	—	—	—	—	13.47	17.11	—	—	—	—	8.32	11.48	—	—	—	—
		64	30.71	21.25	—	—	—	—	—	14.68	—	—	—	—	—	9.05	—	—	—	—	—
		16	10.26	7.08	12.33	16.84	8.47	15.35	22.06	4.88	9.39	—	6.21	12.23	—	3.02	6.84	—	4.30	9.52	—
		24	13.07	9.52	14.03	17.07	12.54	19.25	24.88	6.59	10.42	—	9.42	15.29	—	4.04	7.23	—	6.71	11.79	—
		32	15.43	11.67	14.71	17.21	16.89	22.52	28.11	8.06	10.61	—	12.93	17.87	—	4.87	6.97	—	9.43	13.73	—
16	2	40	16.83	13.31	15.81	16.80	21.12	26.70	30.87	9.20	11.18	—	16.47	21.27	—	5.57	7.22	—	12.32	16.59	—
		48	17.87	14.78	15.76	16.42	25.67	29.84	34.09	10.15	10.88	—	20.24	23.89	—	6.19	6.68	—	15.56	18.74	—
		56	17.97	15.66	16.32	—	29.73	33.99	—	10.78	11.14	—	23.79	27.42	—	6.58	6.73	—	18.63	21.79	—
		64	17.86	16.43	—	—	34.10	—	—	11.26	—	—	27.53	—	—	6.84	—	—	21.90	—	—

CONTINUED

Table 15—Continued

Ditch (inches)	Basal area (square feet)	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		8	9.64	3.33	9.03	12.38	11.31	16.56	21.07	3.66	6.76	—	9.11	13.62	—	2.24	4.80	—	7.25	11.67	—
		24	7.81	7.25	10.60	13.09	14.78	19.29	22.33	4.98	7.77	—	11.85	15.67	—	3.02	5.29	—	9.29	12.49	—
		32	9.89	9.02	11.51	14.76	17.71	20.75	23.25	6.18	8.24	—	14.09	16.65	—	3.71	5.37	—	10.91	13.01	—
16		40	10.46	10.44	12.69	14.00	19.68	22.18	23.17	7.17	8.96	—	15.58	17.56	—	4.30	5.77	—	11.94	13.59	—
		48	11.36	11.79	13.40	14.28	21.28	22.27	22.93	8.05	9.08	—	16.65	17.39	—	4.86	5.64	—	12.69	13.18	—
		56	11.74	12.52	13.90	—	21.89	22.55	—	8.70	9.57	—	17.01	17.37	—	5.26	5.89	—	12.81	12.96	—
		64	12.06	13.61	—	—	22.26	—	—	9.28	—	—	17.08	—	—	5.59	—	—	12.67	—	—
		16	16.80	9.44	18.88	28.51	—	—	—	6.45	15.00	—	—	—	—	4.31	12.10	—	—	—	—
		24	22.86	12.82	22.45	30.58	—	—	—	8.94	17.57	—	—	—	—	6.04	13.77	—	—	—	—
		32	28.80	16.42	24.55	32.64	—	—	—	11.55	18.62	—	—	—	—	7.75	14.09	—	—	—	—
18	1	40	33.86	19.58	27.67	33.63	—	—	—	13.65	20.68	—	—	—	—	9.12	15.43	—	—	—	—
		48	38.80	22.73	28.69	34.74	—	—	—	15.74	21.16	—	—	—	—	10.49	15.31	—	—	—	—
		56	42.48	25.01	31.06	—	—	—	—	17.42	22.63	—	—	—	—	11.63	16.42	—	—	—	—
		64	46.24	27.30	—	—	—	—	—	18.86	—	—	—	—	—	12.66	—	—	—	—	—
		16	15.47	9.15	16.75	23.67	10.67	20.22	29.84	6.31	13.03	—	7.79	16.34	—	4.22	10.25	—	5.66	13.43	—
		24	20.01	12.21	19.12	24.04	15.68	25.30	33.43	8.49	14.58	—	11.80	20.43	—	5.71	11.05	—	8.89	16.62	—
		32	23.96	15.17	20.09	24.32	21.35	29.48	37.56	10.63	14.74	—	16.47	23.54	—	7.10	10.66	—	12.67	19.02	—
18	2	40	26.53	17.52	21.76	23.75	26.91	35.00	40.95	12.17	15.65	—	20.97	28.00	—	8.09	11.07	—	16.45	22.76	—
		48	28.61	19.68	21.67	23.24	32.92	38.87	44.95	13.57	15.24	—	25.93	31.29	—	9.00	10.35	—	20.68	25.50	—
		56	29.35	20.93	22.50	—	38.14	44.19	—	14.50	15.60	—	30.55	35.75	—	9.62	10.53	—	24.76	29.55	—
		64	29.79	22.06	—	—	43.75	—	—	15.16	—	—	35.31	—	—	10.09	—	—	29.11	—	—
		16	9.95	7.12	12.75	18.12	14.69	22.29	29.20	4.89	9.80	—	11.85	18.57	—	3.25	7.59	—	9.75	15.79	—
		24	13.97	9.61	14.98	19.12	19.15	26.06	30.98	6.66	11.31	—	15.43	21.52	—	4.45	8.48	—	12.65	17.99	—
		32	15.95	12.10	16.24	20.08	23.18	28.10	32.34	8.43	11.87	—	18.64	22.75	—	5.60	8.56	—	15.11	18.67	—
18	3	40	18.03	14.16	18.00	20.36	26.02	30.25	32.25	9.79	12.96	—	20.66	24.15	—	6.48	9.18	—	16.59	19.57	—
		48	19.90	16.14	18.49	20.69	28.39	30.38	31.95	11.09	13.08	—	22.28	23.95	—	7.31	8.99	—	17.71	19.07	—
		56	20.94	17.45	19.65	—	29.34	30.91	—	12.04	13.76	—	22.91	24.01	—	7.95	9.43	—	18.02	18.93	—
		64	21.87	18.71	—	—	29.98	—	—	12.82	—	—	23.08	—	—	8.49	—	—	18.00	—	—
		16	23.64	11.62	24.67	37.95	—	—	—	8.15	19.92	—	—	—	—	5.84	16.89	—	—	—	—
		24	32.37	15.94	29.22	40.26	—	—	—	11.19	23.03	—	—	—	—	8.16	19.02	—	—	—	—
		32	41.05	20.55	31.58	42.85	—	—	—	14.35	24.45	—	—	—	—	10.34	19.64	—	—	—	—
20	1	40	48.28	24.34	35.62	43.94	—	—	—	17.22	27.12	—	—	—	—	12.40	21.65	—	—	—	—
		48	55.18	28.42	36.75	45.03	—	—	—	19.93	27.41	—	—	—	—	14.46	21.35	—	—	—	—
		56	60.87	31.35	39.64	—	—	—	—	22.02	29.61	—	—	—	—	15.96	22.95	—	—	—	—
		64	66.23	34.28	—	—	—	—	—	24.25	—	—	—	—	—	17.59	—	—	—	—	—
		16	22.16	11.49	22.26	32.29	13.10	26.15	39.43	8.05	17.65	—	9.64	21.40	—	5.76	14.71	—	7.32	18.37	—
		24	29.04	15.38	25.41	32.60	19.27	32.55	43.59	10.77	19.57	—	14.52	26.36	—	7.84	15.79	—	11.49	22.35	—
		32	35.16	19.29	26.47	33.05	26.43	37.46	48.73	13.44	19.90	—	20.23	30.33	—	9.66	15.49	—	16.22	25.52	—
20	2	40	39.40	22.24	28.82	32.29	33.23	44.50	52.82	15.66	21.21	—	26.10	36.01	—	11.25	16.33	—	21.29	30.54	—
		48	43.00	25.21	28.68	31.51	40.90	49.22	57.50	17.61	20.56	—	32.40	39.89	—	12.72	15.29	—	26.93	33.82	—
		56	44.68	27.00	29.83	—	47.55	55.83	—	18.88	21.33	—	38.21	45.80	—	13.61	15.71	—	32.15	39.14	—
		64	45.87	28.64	—	—	54.63	—	—	20.13	—	—	44.61	—	—	14.52	—	—	37.94	—	—
		16	15.12	9.16	17.44	25.47	18.53	29.29	39.33	6.40	13.69	—	15.09	24.69	—	4.56	11.30	—	12.80	21.75	—
		24	20.15	12.41	20.44	26.63	24.26	34.30	41.48	8.66	15.63	—	19.66	28.46	—	6.27	12.53	—	16.72	24.68	—
		32	24.85	15.74	21.93	27.93	29.60	36.79	43.37	10.94	16.45	—	23.76	30.21	—	7.83	12.78	—	19.98	25.80	—
20	3	40	28.40	18.38	24.39	28.23	33.24	39.82	43.29	12.90	17.97	—	26.67	32.22	—	9.23	13.85	—	22.25	27.33	—
		48	31.67	21.12	24.96	28.53	36.55	40.02	42.84	14.70	18.01	—	28.95	31.89	—	10.58	13.51	—	24.06	26.62	—
		56	33.68	22.95	26.51	—	38.00	40.83	—	15.99	19.12	—	29.88	32.32	—	11.49	14.25	—	24.61	26.71	—
		64	35.49	24.71	—	—	39.02	—	—	17.31	—	—	30.52	—	—	12.45	—	—	24.90	—	—
		16	32.24	13.52	—	—	—	—	—	9.55	—	—	—	—	—	7.51	—	—	—	—	—
		24	44.20	18.90	36.32	51.13	—	—	—	13.40	29.14	—	—	—	—	10.50	25.53	—	—	—	—
		32	56.24	24.27	39.09	53.84	—	—	—	17.10	30.61	—	—	—	—	13.49	26.18	—	—	—	—
22	1	40	66.39	28.94	43.69	54.75	—	—	—	20.46	33.76	—	—	—	—	16.03	28.81	—	—	—	—
		48	76.49	33.59	44.65	55.67	—	—	—	23.66	33.53	—	—	—	—	18.71	27.97	—	—	—	—
		56	84.16	36.99	48.01	—	—	—	—	25.87	35.54	—	—	—	—	20.31	29.68	—	—	—	—
		64	91.78	40.38	—	—	—	—	—	27.92	—	—	—	—	—	22.05	—	—	—	—	—

		16	30.65	13.48	—	—	15.11	—	—	9.52	—	—	11.14	—	—	7.47	—	—	9.09	—	—
		24	40.43	18.39	32.02	42.24	22.67	40.09	54.90	13.03	25.20	—	17.17	32.91	—	10.19	21.75	—	14.27	29.30	—
		32	49.40	23.04	33.27	42.46	31.11	45.93	60.68	16.22	25.41	—	23.94	37.45	—	12.77	21.29	—	20.33	33.02	—
22	2	40	55.90	26.78	35.97	41.22	39.44	54.18	65.25	18.92	27.01	—	30.96	44.26	—	14.80	22.51	—	26.53	39.31	—
		48	61.59	30.27	35.53	40.00	48.49	59.56	70.57	21.31	25.77	—	38.57	48.44	—	16.81	20.86	—	33.62	42.88	—
		56	64.66	32.46	36.93	—	56.49	67.51	—	22.70	26.32	—	45.37	55.04	—	17.79	21.26	—	39.81	49.18	—
		64	67.11	34.47	—	—	65.05	—	—	23.87	—	—	52.59	—	—	18.80	—	—	46.72	—	—
		16	21.87	10.38	—	—	22.26	—	—	7.69	—	—	18.30	—	—	6.03	—	—	16.25	—	—
		24	29.32	14.99	26.13	35.03	29.50	43.13	53.36	10.63	20.52	—	24.15	36.31	—	8.31	17.66	—	21.31	32.86	—
		32	36.44	19.00	27.90	36.35	36.01	46.23	55.42	13.39	21.35	—	29.19	38.37	—	10.53	17.90	—	25.74	34.25	—
22	3	40	41.99	22.35	30.79	36.44	40.68	49.87	55.12	15.80	23.24	—	32.82	40.91	—	12.35	19.41	—	28.70	36.41	—
		48	47.20	25.59	31.24	36.54	44.67	49.92	54.39	18.03	22.90	—	35.71	40.16	—	14.21	18.67	—	31.21	35.25	—
		56	50.62	27.82	33.12	—	46.50	50.97	—	19.48	23.94	—	36.75	40.37	—	15.26	19.51	—	31.83	35.30	—
		64	53.77	29.97	—	—	47.82	—	—	20.79	—	—	37.22	—	—	16.36	—	—	32.15	—	—
		16	42.27	14.89	—	—	—	—	—	11.02	—	—	—	—	—	9.35	—	—	—	—	—
		24	58.30	20.85	—	—	—	—	—	15.59	—	—	—	—	—	13.07	—	—	—	—	—
		32	74.26	26.79	45.74	64.61	—	—	—	19.97	37.59	—	—	—	—	16.76	33.72	—	—	—	—
24	1	40	87.98	32.02	50.89	65.49	—	—	—	23.86	41.40	—	—	—	—	20.00	36.88	—	—	—	—
		48	101.49	37.38	51.99	66.36	—	—	—	27.90	41.42	—	—	—	—	23.38	36.44	—	—	—	—
		56	111.40	42.08	56.45	—	—	—	—	31.51	44.97	—	—	—	—	26.53	39.38	—	—	—	—
		64	121.26	46.59	—	—	—	—	—	35.11	—	—	—	—	—	29.52	—	—	—	—	—
		16	40.65	14.93	—	—	16.51	—	—	11.04	—	—	12.64	—	—	9.36	—	—	10.97	—	—
		24	54.15	20.43	—	—	25.01	—	—	15.25	—	—	19.74	—	—	12.77	—	—	17.22	—	—
		32	66.50	25.62	39.23	51.60	34.55	53.50	72.37	19.07	31.58	—	27.73	45.34	—	15.99	27.96	—	24.52	41.48	—
24	2	40	75.86	29.87	42.24	49.93	44.14	63.01	77.61	22.23	33.56	—	35.98	53.52	—	18.60	29.43	—	32.12	49.00	—
		48	84.11	33.99	41.68	48.27	54.76	69.37	83.74	25.31	32.26	—	45.27	58.80	—	21.18	27.83	—	40.75	53.82	—
		56	88.58	37.21	43.80	—	64.90	79.27	—	27.79	33.82	—	54.33	67.79	—	23.36	28.98	—	49.35	62.20	—
		64	92.33	40.04	—	—	75.52	—	—	30.07	—	—	64.04	—	—	25.23	—	—	58.45	—	—
		16	29.96	12.07	—	—	25.63	—	—	8.92	—	—	21.74	—	—	7.55	—	—	20.06	—	—
		24	40.51	16.68	—	—	34.06	—	—	12.44	—	—	28.88	—	—	10.41	—	—	26.41	—	—
		32	50.56	21.16	33.07	44.44	41.56	55.17	67.54	15.73	26.67	—	35.01	47.53	—	13.18	23.63	—	31.93	43.91	—
24	3	40	58.67	24.96	36.32	44.33	47.06	59.42	67.12	18.56	28.97	—	39.41	50.75	—	15.52	25.47	—	35.79	46.62	—
		48	66.25	28.74	36.75	44.23	51.85	59.54	66.12	21.39	28.67	—	43.17	50.12	—	17.89	24.86	—	39.04	45.69	—
		56	71.15	31.86	39.33	—	54.64	61.23	—	23.78	30.65	—	45.22	51.25	—	19.97	26.44	—	40.79	46.41	—
		64	75.73	34.75	—	—	56.65	—	—	26.07	—	—	46.68	—	—	21.86	—	—	41.83	—	—
		16	53.96	16.31	—	—	—	—	—	12.13	—	—	—	—	—	10.87	—	—	—	—	—
		24	74.79	22.90	—	—	—	—	—	17.02	—	—	—	—	—	15.27	—	—	—	—	—
		32	95.36	29.63	—	—	—	—	—	22.07	—	—	—	—	—	19.65	—	—	—	—	—
26	1	40	113.20	35.61	59.33	77.27	—	—	—	26.60	48.70	—	—	—	—	23.70	45.33	—	—	—	—
		48	130.96	41.56	59.51	77.38	—	—	—	30.94	47.71	—	—	—	—	27.57	44.07	—	—	—	—
		56	144.69	45.78	63.65	—	—	—	—	33.98	50.86	—	—	—	—	30.34	46.78	—	—	—	—
		64	158.36	49.98	—	—	—	—	—	37.19	—	—	—	—	—	33.11	—	—	—	—	—
		16	52.37	16.48	—	—	17.91	—	—	12.24	—	—	13.72	—	—	10.97	—	—	12.47	—	—
		24	70.28	22.63	—	—	27.41	—	—	16.81	—	—	21.54	—	—	15.06	—	—	19.79	—	—
		32	86.66	28.64	—	—	38.34	—	—	21.30	—	—	30.78	—	—	18.95	—	—	28.35	—	—
26	2	40	99.36	33.62	49.83	59.81	49.45	73.17	91.11	25.07	39.97	—	40.44	62.54	—	22.32	36.85	—	37.55	59.17	—
		48	110.86	38.32	48.31	57.17	61.66	79.61	97.48	28.47	37.62	—	51.03	67.81	—	25.34	34.33	—	47.67	64.17	—
		56	117.96	41.21	50.08	—	72.51	90.38	—	30.53	38.76	—	60.72	77.59	—	27.23	35.16	—	57.08	73.52	—
		64	124.12	43.91	—	—	84.22	—	—	32.59	—	—	71.43	—	—	28.99	—	—	67.35	—	—
		16	39.42	13.45	—	—	29.42	—	—	9.97	—	—	25.19	—	—	8.93	—	—	23.92	—	—
		24	53.67	18.65	—	—	39.24	—	—	13.83	—	—	33.42	—	—	12.39	—	—	31.68	—	—
		32	67.20	23.84	—	—	48.10	—	—	17.71	—	—	40.76	—	—	15.75	—	—	38.42	—	—
26	3	40	78.29	28.30	43.21	53.53	54.68	70.89	80.88	21.07	34.79	—	46.13	61.04	—	18.75	32.12	—	43.39	57.92	—
		48	88.87	32.63	42.96	52.79	60.32	70.30	79.17	24.21	33.72	—	50.46	59.62	—	21.55	30.87	—	47.34	56.32	—
		56	96.28	35.54	45.37	—	62.89	71.75	—	26.30	35.46	—	52.20	60.43	—	23.45	32.31	—	48.91	56.83	—
		64	103.29	38.36	—	—	64.74	—	—	28.45	—	—	53.42	—	—	25.30	—	—	49.82	—	—
		16	68.81	18.56	—	—	—	—	—	13.66	—	—	—	—	—	12.89	—	—	—	—	—
		24	92.78	26.06	—	—	—	—	—	19.33	—	—	—	—	—	18.29	—	—	—	—	—
		32	118.65	33.73	—	—	—	—	—	24.99	—	—	—	—	—	23.49	—	—	—	—	—
28	1	40	141.26	40.39	—	—	—	—	—	29.90	—	—	—	—	—	28.15	—	—	—	—	—
		48	163.59	47.03	—	—	—	—	—	34.78	—	—	—	—	—	32.78	—	—	—	—	—
		56	180.59	52.33	—	—	—	—	—	38.44	—	—	—	—	—	36.38	—	—	—	—	—
		64	197.51	57.61	—	—	—	—	—	42.10	—	—	—	—	—	39.80	—	—	—	—	—

CONTINUED

Table 15—Continued

D.b.h. (inches)	Butt log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	65.33	18.85						13.87						13.09					
		24	88.05	25.94						19.23						18.19					
		32	109.14	32.87						24.33						22.87					
28	2	40	125.81	38.53						28.49						26.82					
		48	140.90	43.89						32.42						30.55					
		56	150.22	47.74						35.04						33.15					
		64	158.46	51.35						37.49						35.43					
		16	49.99	15.53						11.42						10.77					
		24	68.29	21.57						15.97						15.10					
		32	85.89	27.60						20.41						19.19					
28	3	40	100.53	32.70						24.15						22.74					
		48	114.42	37.66						27.79						26.19					
		56	124.08	41.43						30.39						28.74					
		64	133.27	45.09						32.92						31.10					
		16	81.25	20.13						15.71						14.88					
		24	113.17	28.32						22.03						20.71					
		32	144.96	36.49						28.33						26.91					
30	1	40	172.73	44.38						34.41						32.52					
		48	200.21	52.44						40.85						38.49					
		56	221.11	59.07						46.36						43.74					
		64	241.93	65.68						51.47						48.79					
		16	80.00	20.54						16.02						15.17					
		24	108.32	28.35						22.04						20.72					
		32	134.76	35.82						27.79						26.39					
30	2	40	155.81	42.67						33.06						31.24					
		48	175.05	49.35						38.40						36.18					
		56	187.17	54.37						42.59						40.17					
		64	198.04	59.09						46.21						43.77					
		16	62.06	17.06						13.29						12.58					
		24	85.14	23.75						18.45						17.34					
		32	107.40	30.30						23.49						22.30					
30	3	40	125.98	36.44						28.21						26.65					
		48	143.71	42.56						33.09						31.17					
		56	156.14	47.38						37.08						34.97					
		64	168.03	52.07						40.68						38.53					

Table 16.—Ten-year value increase for red maple, in dollars

D.b.h. (inches)	Butt-log grade	Mer-chant-able height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	2.10	2.58	3.71	4.61	3.48	5.17	6.74	1.91	2.85	3.61	2.74	4.19	5.58	1.57	2.44	—	2.37	3.72	—
		24	2.50	3.32	4.22	4.64	4.77	6.34	7.47	2.45	3.22	3.50	3.79	5.18	6.10	2.04	2.69	—	3.32	4.57	—
		32	2.75	3.97	4.39	4.62	6.09	7.22	8.26	2.97	3.25	3.37	4.93	5.86	6.70	2.44	2.68	—	4.32	5.16	—
12	2	40	2.73	4.41	4.64	4.43	7.24	8.28	8.82	3.27	3.39	3.13	5.87	6.71	7.13	2.69	2.76	—	5.18	5.95	—
		48	2.60	4.77	4.56	4.21	8.41	8.95	9.42	3.52	3.26	2.86	6.24	7.26	7.58	2.90	2.62	—	6.08	6.44	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.58	1.80	2.43	2.98	4.10	5.24	6.14	1.32	1.80	2.22	3.43	4.37	5.14	1.08	1.49	—	3.10	3.96	—
		24	.65	2.36	2.90	3.23	5.16	6.06	6.49	1.73	2.14	2.35	4.30	5.06	5.35	1.41	1.75	—	3.88	4.53	—
		32	.67	2.88	3.21	3.46	6.04	6.47	6.70	2.13	2.33	2.47	5.04	5.33	5.44	1.73	1.89	—	4.51	4.75	—
12	3	40	.61	3.27	3.52	3.55	6.53	6.76	6.55	2.40	2.54	2.50	5.39	5.51	5.25	1.95	2.04	—	4.81	4.89	—
		48	.50	3.63	3.66	3.64	6.87	6.66	6.31	2.64	2.61	2.52	5.62	5.36	4.96	2.15	2.09	—	4.99	4.72	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.00	.00	.00	.00	2.37	3.01	3.55	.00	.00	.00	1.90	2.38	2.80	.00	.00	—	1.65	2.07	—
		24	.00	.00	.00	.00	3.01	3.55	3.88	.00	.00	.00	2.38	2.80	3.00	.00	.00	—	2.07	2.40	—
		32	.00	.00	.00	.00	3.55	3.88	4.13	.00	.00	.00	2.80	3.00	3.14	.00	.00	—	2.40	2.56	—
12	4	40	.00	.00	.00	.00	3.88	4.13	4.16	.00	.00	.00	3.00	3.14	3.11	.00	.00	—	2.56	2.65	—
		48	.00	.00	.00	.00	4.13	4.16	4.13	.00	.00	.00	3.14	3.11	3.02	.00	.00	—	2.65	2.59	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	4.01	3.74	5.87	7.66	4.89	7.75	10.44	2.83	4.68	6.23	3.91	6.45	8.84	2.21	3.87	—	3.24	5.56	—
		24	4.95	4.93	6.72	7.82	6.81	9.50	11.57	3.74	5.29	6.19	5.51	7.90	9.69	2.93	4.26	—	4.62	6.74	—
		32	5.71	5.96	7.06	7.89	8.74	10.81	12.74	4.53	5.43	6.08	7.13	8.93	10.60	3.50	4.27	—	5.98	7.59	—
14	2	40	6.00	6.77	7.60	7.71	10.52	12.46	13.63	5.14	5.79	5.81	8.64	10.32	11.33	3.98	4.51	—	7.30	8.80	—
		48	6.11	7.48	7.60	7.55	12.34	13.52	14.65	5.67	5.70	5.58	10.20	11.22	12.20	4.39	4.34	—	8.69	9.55	—
		56	5.86	7.85	7.80	—	13.77	14.91	—	5.96	5.83	—	11.47	12.45	—	4.59	4.40	—	9.81	10.65	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	1.90	2.85	4.30	5.61	5.86	7.98	9.77	2.14	3.36	4.45	4.94	6.80	8.34	1.65	2.71	—	4.32	5.99	—
		24	2.38	3.81	5.13	6.08	7.50	9.29	10.39	2.87	3.97	4.73	6.31	7.86	8.76	2.23	3.14	—	5.50	6.83	—
		32	2.80	4.71	5.67	6.51	8.87	9.97	10.80	3.55	4.32	4.98	7.44	8.34	8.99	2.72	3.36	—	6.41	7.18	—
14	3	40	3.00	5.46	6.30	6.73	9.77	10.59	10.71	4.11	4.78	5.09	8.14	8.78	8.81	3.15	3.70	—	6.98	7.50	—
		48	3.14	6.16	6.59	6.97	10.45	10.57	10.52	4.64	4.95	5.22	8.64	8.67	8.55	3.56	3.78	—	7.36	7.31	—
		56	3.11	6.62	7.00	—	10.60	10.55	—	4.98	5.25	—	8.70	8.58	—	3.81	3.99	—	7.34	7.15	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	0.00	0.00	0.00	0.00	4.75	6.19	7.51	0.00	0.00	0.00	4.04	5.25	6.35	0.00	0.00	—	3.55	4.61	—
		24	.00	.00	.00	.00	6.19	7.51	8.46	.00	.00	.00	5.25	6.35	7.11	.00	.00	—	4.61	5.52	—
		32	.00	.00	.00	.00	7.51	8.46	9.31	.00	.00	.00	6.35	7.11	7.78	.00	.00	—	5.52	6.16	—
14	4	40	.00	.00	.00	.00	8.46	9.31	9.73	.00	.00	.00	7.11	7.78	8.09	.00	.00	—	6.16	6.70	—
		48	.00	.00	.00	.00	9.31	9.73	10.11	.00	.00	.00	7.78	8.09	8.36	.00	.00	—	6.70	6.92	—
		56	.00	.00	.00	.00	9.73	10.11	—	.00	.00	.00	8.09	8.36	—	.00	.00	—	6.92	7.10	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	7.91	4.95	9.29	13.51	—	—	—	4.02	8.00	11.79	—	—	—	2.96	6.57	—	—	—	—
		24	10.45	6.75	10.97	14.12	—	—	—	5.46	9.25	12.17	—	—	—	4.03	7.39	—	—	—	—
		32	12.84	8.58	11.73	14.72	—	—	—	6.86	9.78	12.54	—	—	—	5.00	7.67	—	—	—	—
16	1	40	14.64	9.94	12.92	14.99	—	—	—	7.98	10.74	12.54	—	—	—	5.87	8.31	—	—	—	—
		48	16.31	11.25	13.32	15.19	—	—	—	9.06	10.87	12.62	—	—	—	6.64	8.24	—	—	—	—
		56	17.33	12.31	14.17	—	—	—	—	9.86	11.61	—	—	—	—	7.23	8.78	—	—	—	—
		64	18.31	13.19	—	—	—	—	—	10.63	—	—	—	—	—	7.80	—	—	—	—	—

CONTINUED

Table 16—Continued

D.b.h. (inches)	Butt-log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
16	2	16	6.84	4.65	8.08	11.15	6.02	10.37	14.59	3.77	6.88	9.59	5.09	9.08	12.87	2.77	5.55	—	4.04	7.65	—
		24	8.69	6.23	9.30	11.24	8.52	12.73	15.89	5.03	7.74	9.50	7.23	11.02	13.93	3.70	6.04	—	5.80	9.15	—
		32	10.24	7.75	9.69	11.29	11.19	14.34	17.32	6.19	7.95	9.37	9.47	12.39	15.14	4.49	6.06	—	7.61	10.28	—
		40	11.14	8.79	10.39	11.07	13.44	16.42	18.50	7.05	8.47	8.98	11.49	14.24	16.04	5.16	6.35	—	9.37	11.82	—
		48	11.79	9.74	10.42	10.78	15.77	17.85	19.72	7.83	8.33	8.63	13.59	15.40	17.15	5.70	6.08	—	11.17	12.77	—
		56	11.81	10.40	10.76	—	17.82	19.69	—	8.30	8.60	—	15.37	17.12	—	6.05	6.23	—	12.75	14.30	—
		64	11.69	10.88	—	—	19.81	—	—	8.73	—	—	17.21	—	—	6.36	—	—	14.42	—	—
16	3	16	4.04	3.77	6.34	8.79	7.45	10.88	13.95	3.04	5.33	7.47	6.57	9.68	12.39	2.21	4.22	—	5.57	8.35	—
		24	5.25	5.12	7.57	9.35	9.66	12.73	14.68	4.12	6.25	7.84	8.47	11.17	12.94	3.00	4.81	—	7.14	9.48	—
		32	6.35	6.47	8.25	9.89	11.64	13.58	15.17	5.16	6.75	8.20	10.08	11.84	13.26	3.72	5.11	—	8.38	9.95	—
		40	7.11	7.49	9.13	10.20	12.82	14.41	15.10	5.98	7.44	8.32	11.08	12.50	13.00	4.34	5.57	—	9.18	10.37	—
		48	7.78	8.46	9.54	10.46	13.75	14.43	14.79	6.78	7.66	8.48	11.83	12.34	12.64	4.90	5.63	—	9.71	10.08	—
		56	8.09	9.22	10.14	—	14.12	14.47	—	7.34	8.17	—	12.02	12.32	—	5.31	5.99	—	9.77	9.95	—
		64	8.36	9.87	—	—	14.20	—	—	7.90	—	—	12.05	—	—	5.72	—	—	9.68	—	—
18	1	16	11.93	6.35	12.79	18.87	—	—	—	5.16	11.08	16.74	—	—	—	3.25	8.48	—	—	—	—
		24	15.92	8.80	14.88	19.71	—	—	—	7.09	12.75	17.21	—	—	—	4.49	9.48	—	—	—	—
		32	19.71	11.09	15.92	20.53	—	—	—	8.96	13.42	17.67	—	—	—	5.69	9.53	—	—	—	—
		40	22.62	13.00	17.62	20.81	—	—	—	10.50	14.75	17.62	—	—	—	6.62	10.27	—	—	—	—
		48	25.38	14.86	18.05	20.99	—	—	—	11.99	14.86	17.57	—	—	—	7.52	10.03	—	—	—	—
		56	27.18	16.25	19.19	—	—	—	—	13.06	15.77	—	—	—	—	8.22	10.58	—	—	—	—
		64	28.93	17.44	—	—	—	—	—	14.02	—	—	—	—	—	8.83	—	—	—	—	—
18	2	16	10.61	6.05	11.35	16.03	7.68	14.11	20.19	4.91	9.74	14.06	6.49	12.40	18.06	3.09	7.30	—	4.58	9.80	—
		24	13.72	8.24	12.92	16.23	11.00	17.08	21.91	6.63	10.95	13.95	9.29	14.95	19.41	4.18	7.92	—	6.69	11.68	—
		32	16.43	10.21	13.52	16.38	14.37	19.20	23.81	8.24	11.24	13.81	12.24	16.70	20.95	5.21	7.71	—	8.97	12.81	—
		40	18.19	11.76	14.62	16.07	17.44	22.05	25.24	9.48	12.05	13.28	14.94	19.19	22.06	5.95	8.05	—	11.05	14.71	—
		48	19.61	13.19	14.65	15.69	20.63	23.82	26.76	10.63	11.85	12.75	17.76	20.63	23.34	6.63	7.60	—	13.28	15.79	—
		56	20.12	14.14	15.18	—	23.32	26.25	—	11.35	12.24	—	20.13	22.84	—	7.10	7.77	—	15.29	17.65	—
		64	20.42	14.88	—	—	25.95	—	—	11.94	—	—	22.54	—	—	7.47	—	—	17.35	—	—
18	3	16	7.08	5.09	9.32	13.27	9.58	14.88	19.56	4.12	7.93	11.55	8.44	13.27	17.59	2.57	5.82	—	6.61	10.82	—
		24	9.37	7.02	10.97	14.07	12.59	17.27	20.58	5.64	9.25	12.05	10.98	15.30	18.30	3.53	6.60	—	8.53	12.27	—
		32	11.51	8.84	11.94	14.86	15.13	18.44	21.30	7.12	9.91	12.54	13.16	16.17	18.74	4.46	6.77	—	10.13	12.63	—
		40	13.09	10.35	13.27	15.23	16.86	19.71	21.17	8.32	10.95	12.67	14.58	17.15	18.37	5.18	7.34	—	11.04	13.14	—
		48	14.55	11.81	13.77	15.55	18.25	19.71	20.74	9.49	11.21	12.80	15.69	16.91	17.80	5.88	7.30	—	11.68	12.66	—
		56	15.44	12.89	14.66	—	18.82	19.86	—	10.32	11.91	—	16.03	16.92	—	6.42	7.72	—	11.78	12.45	—
		64	16.26	13.84	—	—	19.04	—	—	11.09	—	—	16.10	—	—	6.90	—	—	11.62	—	—
20	1	16	17.09	7.70	16.44	24.86	—	—	—	6.56	14.84	22.93	—	—	—	3.79	11.12	—	—	—	—
		24	23.01	10.53	18.95	25.84	—	—	—	8.93	17.01	23.50	—	—	—	5.21	12.25	—	—	—	—
		32	28.67	13.28	20.18	26.70	—	—	—	11.35	17.83	24.05	—	—	—	6.59	12.22	—	—	—	—
		40	33.13	15.72	22.24	26.84	—	—	—	13.37	19.60	23.93	—	—	—	7.76	13.15	—	—	—	—
		48	37.37	17.99	22.59	26.89	—	—	—	15.35	19.69	23.82	—	—	—	8.90	12.69	—	—	—	—
		56	40.24	19.72	24.02	—	—	—	—	16.82	20.95	—	—	—	—	9.82	13.33	—	—	—	—
		64	42.95	21.31	—	—	—	—	—	18.24	—	—	—	—	—	10.62	—	—	—	—	—
20	2	16	15.51	7.40	14.81	21.56	9.28	18.02	26.44	6.29	13.29	19.74	8.13	16.42	24.50	3.63	9.75	—	5.37	12.70	—
		24	20.35	9.97	16.72	21.77	13.18	21.60	28.50	8.45	14.90	19.61	11.59	19.67	26.15	4.91	10.44	—	7.86	14.91	—
		32	24.67	12.40	17.45	21.85	17.28	24.18	30.70	10.59	15.29	19.45	15.35	21.83	28.05	6.12	10.10	—	10.59	16.22	—
		40	27.67	14.45	18.85	21.34	21.17	27.69	32.30	12.29	16.44	18.74	18.83	25.05	29.39	7.10	10.58	—	13.22	18.60	—
		48	30.24	16.28	18.78	20.76	25.13	29.73	34.02	13.87	16.17	18.04	22.48	26.82	30.96	8.01	9.89	—	16.04	19.82	—
		56	31.46	17.55	19.54	—	28.50	32.80	—	14.94	16.82	—	25.60	29.73	—	8.67	10.10	—	18.60	22.11	—
		64	32.36	18.64	—	—	31.91	—	—	15.93	—	—	28.84	—	—	9.21	—	—	21.22	—	—
20	3	16	11.20	6.39	12.54	18.44	11.71	19.12	25.87	5.42	11.21	16.81	10.61	17.61	24.06	3.11	8.08	—	7.95	14.07	—
		24	15.01	8.73	14.63	19.42	15.31	22.06	27.11	7.39	13.00	17.46	13.79	20.24	24.95	4.27	9.01	—	10.25	15.78	—
		32	18.62	11.01	15.81	20.31	18.45	23.50	27.90	9.38	13.84	18.09	16.63	21.33	25.49	5.39	9.14	—	12.17	16.15	—
		40	21.42	13.01	17.52	20.65	20.71	25.11	27.60	11.05	15.30	18.21	18.54	22.70	24.99	6.35	9.90	—	13.35	16.83	—
		48	24.05	14.89	18.02	20.92	22.48	24.97	26.95	12.67	15.58	18.34	20.07	22.36	24.24	7.27	9.72	—	14.20	16.09	—
		56	25.76	16.31	19.21	—	23.25	25.24	—	13.87	16.62	—	20.65	22.52	—	8.00	10.24	—	14.37	15.80	—
		64	27.35	17.62	—	—	23.65	—	—	15.03	—	—	20.93	—	—	8.65	—	—	14.22	—	—

		16	23.65	8.97	—	—	—	—	—	7.66	—	—	—	—	—	4.22	—	—	—	—	—
		24	31.94	12.44	23.81	33.24	—	—	—	10.66	21.57	30.57	—	—	—	5.81	15.45	—	—	—	—
		32	40.02	15.73	25.16	34.14	—	—	—	13.49	22.49	31.06	—	—	—	7.37	15.19	—	—	—	—
22	1	40	46.50	18.67	27.66	33.83	—	—	—	16.01	24.57	30.37	—	—	—	8.70	16.33	—	—	—	—
		48	52.72	21.44	27.61	33.54	—	—	—	18.35	24.15	29.72	—	—	—	10.11	15.20	—	—	—	—
		56	57.06	23.28	29.20	—	—	—	—	19.82	25.38	—	—	—	—	10.86	15.82	—	—	—	—
		64	61.20	25.07	—	—	—	—	—	21.24	—	—	—	—	—	11.69	—	—	—	—	—
		16	21.81	8.67	—	—	10.81	—	—	7.41	—	—	9.50	—	—	4.08	—	—	6.06	—	—
		24	28.81	11.87	21.27	28.50	15.57	26.94	36.37	10.18	19.16	26.02	13.79	24.71	33.70	5.54	13.38	—	8.94	18.58	—
		32	35.25	14.82	22.05	28.49	20.49	29.92	38.90	12.71	19.57	25.67	18.26	27.25	35.82	6.93	12.78	—	12.13	19.95	—
22	2	40	39.96	17.34	23.78	27.46	25.22	34.20	40.38	14.87	20.97	24.35	22.55	31.12	36.92	8.07	13.39	—	15.25	22.87	—
		48	44.11	19.63	23.30	26.46	30.04	36.22	42.15	16.81	20.20	23.09	26.96	32.76	38.33	9.23	12.08	—	18.71	23.80	—
		56	46.41	21.01	24.17	—	33.93	39.86	—	17.90	20.79	—	30.47	36.03	—	9.79	12.26	—	21.51	26.48	—
		64	48.28	22.29	—	—	37.98	—	—	18.92	—	—	34.16	—	—	10.38	—	—	24.60	—	—
		16	16.63	7.63	—	—	13.85	—	—	6.52	—	—	12.59	—	—	3.58	—	—	9.26	—	—
		24	22.40	10.56	18.96	25.90	18.27	27.67	34.90	9.06	17.07	23.65	16.58	25.56	32.42	4.92	11.84	—	11.94	19.78	—
		32	28.01	13.36	20.30	26.89	22.07	29.30	35.73	11.46	18.04	24.29	19.96	26.82	32.92	6.24	11.82	—	14.18	20.02	—
22	3	40	32.47	15.84	22.44	26.94	24.84	31.28	34.95	13.59	19.83	24.02	22.36	28.46	31.84	7.36	12.78	—	15.56	20.88	—
		48	36.71	18.19	22.69	26.99	27.03	30.70	33.86	15.58	19.77	23.78	24.21	27.60	30.49	8.53	12.11	—	16.63	19.48	—
		56	39.63	19.77	24.08	—	27.79	30.95	—	16.86	20.86	—	24.68	27.57	—	9.19	12.67	—	16.57	19.04	—
		64	42.38	21.32	—	—	28.19	—	—	18.11	—	—	24.82	—	—	9.91	—	—	16.28	—	—
		16	31.31	9.80	—	—	—	—	—	8.30	—	—	—	—	—	3.86	—	—	—	—	—
		24	42.60	13.63	—	—	—	—	—	11.62	—	—	—	—	—	5.42	—	—	—	—	—
		32	53.51	17.24	29.41	41.17	—	—	—	14.75	26.45	—	—	—	—	6.94	17.14	—	—	—	—
24	1	40	62.51	20.41	32.17	40.64	—	—	—	17.45	28.76	—	—	—	—	8.14	17.99	—	—	—	—
		48	71.07	23.60	32.07	40.34	—	—	—	20.20	28.38	—	—	—	—	9.42	16.38	—	—	—	—
		56	76.88	26.27	34.54	—	—	—	—	22.57	30.44	—	—	—	—	10.58	17.15	—	—	—	—
		64	82.44	28.98	—	—	—	—	—	24.88	—	—	—	—	—	11.59	—	—	—	—	—
		16	29.22	9.51	—	—	11.89	—	—	8.05	—	—	10.39	—	—	3.74	—	—	5.95	—	—
		24	38.98	13.05	—	—	17.24	—	—	11.13	—	—	15.24	—	—	5.18	—	—	9.03	—	—
		32	47.97	16.30	25.89	34.65	22.79	34.95	46.71	13.94	23.13	—	20.29	31.99	—	6.54	14.43	—	12.48	22.68	—
24	2	40	54.83	19.03	27.79	33.25	28.09	39.85	48.32	16.27	24.65	—	25.13	36.44	—	7.57	14.73	—	15.82	25.67	—
		48	60.92	21.70	27.16	32.07	33.75	42.22	50.49	18.56	23.79	—	30.35	38.53	—	8.63	12.92	—	19.57	26.53	—
		56	64.31	23.77	28.68	—	38.84	47.11	—	20.41	25.01	—	35.14	43.01	—	9.53	13.16	—	23.14	29.72	—
		64	67.20	25.79	—	—	44.21	—	—	22.12	—	—	40.12	—	—	10.27	—	—	26.82	—	—
		16	23.15	8.40	—	—	15.58	—	—	7.11	—	—	14.12	—	—	3.29	—	—	9.81	—	—
		24	31.46	11.67	—	—	20.57	—	—	9.94	—	—	18.65	—	—	4.61	—	—	12.70	—	—
		32	39.47	14.77	24.06	33.03	24.80	34.39	43.15	12.62	21.51	—	22.43	31.63	—	5.90	13.51	—	15.04	22.92	—
24	3	40	46.05	17.48	26.45	32.89	27.81	36.57	42.03	14.93	23.51	—	25.05	33.43	—	6.93	14.25	—	16.35	23.51	—
		48	52.29	20.21	26.65	32.93	30.33	35.79	40.70	17.27	23.46	—	27.19	32.42	—	8.01	13.16	—	17.26	21.55	—
		56	56.49	22.46	28.74	—	31.59	36.51	—	19.26	25.20	—	28.23	32.84	—	8.97	13.82	—	17.35	20.99	—
		64	60.49	24.73	—	—	32.50	—	—	21.20	—	—	28.84	—	—	9.81	—	—	16.98	—	—
		16	40.11	10.69	—	—	—	—	—	9.07	—	—	—	—	—	3.81	—	—	—	—	—
		24	54.89	14.78	—	—	—	—	—	12.62	—	—	—	—	—	5.16	—	—	—	—	—
		32	69.09	18.91	—	—	—	—	—	16.21	—	—	—	—	—	6.61	—	—	—	—	—
26	1	40	80.95	22.56	37.58	48.18	—	—	—	19.36	33.77	—	—	—	—	7.97	20.65	—	—	—	—
		48	92.41	26.12	36.72	47.08	—	—	—	22.31	32.59	—	—	—	—	9.19	18.37	—	—	—	—
		56	100.73	28.41	38.77	—	—	—	—	24.28	34.33	—	—	—	—	10.06	18.80	—	—	—	—
		64	108.73	30.76	—	—	—	—	—	26.32	—	—	—	—	—	10.79	—	—	—	—	—
		16	37.76	10.43	—	—	13.04	—	—	8.85	—	—	11.42	—	—	3.71	—	—	6.16	—	—
		24	50.75	14.26	—	—	18.92	—	—	12.17	—	—	16.76	—	—	4.97	—	—	9.30	—	—
		32	62.70	18.01	—	—	25.31	—	—	15.44	—	—	22.61	—	—	6.28	—	—	13.01	—	—
26	2	40	72.02	21.21	32.74	39.87	31.48	46.51	57.11	18.19	29.19	—	28.29	42.70	—	7.47	17.00	—	16.90	29.58	—
		48	80.53	24.24	31.36	37.84	38.00	48.60	58.96	20.69	27.56	—	34.19	44.47	—	8.49	14.51	—	21.07	30.25	—
		56	85.88	26.02	32.50	—	43.26	53.62	—	22.22	28.46	—	39.13	49.18	—	9.17	14.41	—	24.91	33.65	—
		64	90.58	27.79	—	—	48.91	—	—	23.76	—	—	44.47	—	—	9.70	—	—	28.94	—	—
		16	30.69	9.34	—	—	17.50	—	—	7.92	—	—	15.91	—	—	3.30	—	—	10.77	—	—
		24	41.98	12.92	—	—	23.03	—	—	11.02	—	—	20.94	—	—	4.48	—	—	13.74	—	—
		32	52.81	16.52	—	—	27.90	—	—	14.14	—	—	25.32	—	—	5.73	—	—	16.17	—	—
26	3	40	61.84	19.70	31.53	39.87	31.40	42.93	50.06	16.88	28.17	—	28.38	39.38	—	6.91	16.67	—	17.66	27.18	—
		48	70.55	22.81	31.15	39.30	34.22	41.34	47.83	19.46	27.51	—	30.67	37.55	—	7.96	15.02	—	18.47	24.49	—
		56	76.85	24.86	33.00	—	35.05	41.53	—	21.21	29.07	—	31.25	37.49	—	8.72	15.43	—	18.20	23.44	—
		64	82.90	26.95	—	—	35.48	—	—	23.02	—	—	31.44	—	—	9.38	—	—	17.39	—	—

CONTINUED

Table 16—Continued

DBH (inches)	Butt log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of			Increase in butt log grade with height increase (feet) of		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	49.72	11.96	—	—	—	—	—	10.21	—	—	—	—	—	3.69	—	—	—	—	—
		24	68.23	16.81	—	—	—	—	—	14.33	—	—	—	—	—	5.11	—	—	—	—	—
		32	86.20	21.42	—	—	—	—	—	18.36	—	—	—	—	—	6.50	—	—	—	—	—
28	1	40	101.47	25.52	—	—	—	—	—	21.79	—	—	—	—	—	7.68	—	—	—	—	—
		48	115.94	29.39	—	—	—	—	—	25.13	—	—	—	—	—	8.97	—	—	—	—	—
		56	126.87	32.41	—	—	—	—	—	27.53	—	—	—	—	—	9.89	—	—	—	—	—
		64	136.15	35.23	—	—	—	—	—	29.88	—	—	—	—	—	10.67	—	—	—	—	—
		16	47.13	11.74	—	—	—	—	—	10.02	—	—	—	—	—	3.62	—	—	—	—	—
		24	63.61	16.31	—	—	—	—	—	13.90	—	—	—	—	—	4.96	—	—	—	—	—
		32	78.99	20.55	—	—	—	—	—	17.60	—	—	—	—	—	6.22	—	—	—	—	—
28	2	40	91.22	24.19	—	—	—	—	—	20.64	—	—	—	—	—	7.27	—	—	—	—	—
		48	102.36	27.53	—	—	—	—	—	23.52	—	—	—	—	—	8.37	—	—	—	—	—
		56	109.85	29.97	—	—	—	—	—	25.45	—	—	—	—	—	9.11	—	—	—	—	—
		64	115.61	32.16	—	—	—	—	—	27.27	—	—	—	—	—	9.70	—	—	—	—	—
		16	39.08	10.64	—	—	—	—	—	9.08	—	—	—	—	—	3.26	—	—	—	—	—
		24	53.62	14.94	—	—	—	—	—	12.73	—	—	—	—	—	4.51	—	—	—	—	—
		32	67.74	19.05	—	—	—	—	—	16.31	—	—	—	—	—	5.75	—	—	—	—	—
28	3	40	79.65	22.70	—	—	—	—	—	19.36	—	—	—	—	—	6.80	—	—	—	—	—
		48	91.09	26.17	—	—	—	—	—	22.34	—	—	—	—	—	7.93	—	—	—	—	—
		56	99.27	28.87	—	—	—	—	—	24.51	—	—	—	—	—	8.75	—	—	—	—	—
		64	107.16	31.41	—	—	—	—	—	26.63	—	—	—	—	—	9.45	—	—	—	—	—
		16	60.51	13.78	—	—	—	—	—	11.75	—	—	—	—	—	3.08	—	—	—	—	—
		24	83.34	19.16	—	—	—	—	—	16.34	—	—	—	—	—	4.21	—	—	—	—	—
		32	105.54	24.44	—	—	—	—	—	20.84	—	—	—	—	—	5.45	—	—	—	—	—
30	1	40	124.31	29.44	—	—	—	—	—	25.11	—	—	—	—	—	6.50	—	—	—	—	—
		48	142.40	34.47	—	—	—	—	—	29.56	—	—	—	—	—	7.52	—	—	—	—	—
		56	155.40	38.69	—	—	—	—	—	33.26	—	—	—	—	—	8.46	—	—	—	—	—
		64	167.97	42.68	—	—	—	—	—	36.60	—	—	—	—	—	9.37	—	—	—	—	—
		16	57.72	13.57	—	—	—	—	—	11.56	—	—	—	—	—	3.02	—	—	—	—	—
		24	78.27	18.68	—	—	—	—	—	15.92	—	—	—	—	—	4.09	—	—	—	—	—
		32	97.53	23.57	—	—	—	—	—	20.10	—	—	—	—	—	5.24	—	—	—	—	—
30	2	40	112.96	28.07	—	—	—	—	—	23.93	—	—	—	—	—	6.18	—	—	—	—	—
		48	127.13	32.48	—	—	—	—	—	27.84	—	—	—	—	—	7.06	—	—	—	—	—
		56	136.19	36.00	—	—	—	—	—	30.91	—	—	—	—	—	7.83	—	—	—	—	—
		64	144.39	39.20	—	—	—	—	—	33.58	—	—	—	—	—	8.56	—	—	—	—	—
		16	48.68	12.42	—	—	—	—	—	10.58	—	—	—	—	—	2.75	—	—	—	—	—
		24	67.05	17.28	—	—	—	—	—	14.72	—	—	—	—	—	3.76	—	—	—	—	—
		32	84.93	22.05	—	—	—	—	—	18.79	—	—	—	—	—	4.88	—	—	—	—	—
30	3	40	100.05	26.55	—	—	—	—	—	22.63	—	—	—	—	—	5.81	—	—	—	—	—
		48	114.63	31.08	—	—	—	—	—	26.62	—	—	—	—	—	6.73	—	—	—	—	—
		56	125.12	34.85	—	—	—	—	—	29.91	—	—	—	—	—	7.55	—	—	—	—	—
		64	135.27	38.44	—	—	—	—	—	32.91	—	—	—	—	—	8.36	—	—	—	—	—

Table 17.—Ten-year value increase for white ash, in dollars

D.b.h. (inches)	Butt-log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	1.13	1.47	2.18	2.81	2.42	3.55	4.68	1.21	1.84	—	2.12	3.16	—	0.72	1.22	—	1.47	2.31	—
		24	1.38	1.93	2.56	2.92	3.31	4.44	5.26	1.59	2.13	—	2.92	3.93	—	0.97	1.36	—	2.07	2.87	—
		32	1.56	2.38	2.74	3.02	4.26	5.08	5.86	1.95	2.25	—	3.75	4.49	—	1.18	1.39	—	2.69	3.26	—
12	2	40	1.60	2.70	2.98	3.02	5.03	5.82	6.30	2.21	2.44	—	4.45	5.16	—	1.34	1.46	—	3.21	3.76	—
		48	1.60	2.98	3.03	3.00	5.82	6.31	6.74	2.44	2.46	—	5.17	.60	—	1.47	1.42	—	3.76	4.27	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.00	.00	.00	1.03	2.61	3.31	3.94	.00	.00	—	2.34	2.97	—	.00	.00	—	1.85	2.35	—
		24	.00	.00	1.03	2.38	3.31	3.94	4.30	.00	.81	—	2.97	3.51	—	.00	.43	—	2.35	2.74	—
		32	.00	1.03	2.38	4.07	3.94	4.30	4.58	.81	2.07	—	3.51	3.81	—	.43	1.52	—	2.74	2.94	—
12	3	40	.69	1.69	3.38	5.19	3.61	3.89	3.93	1.38	2.96	—	3.12	3.35	—	.83	2.20	—	2.25	2.37	—
		48	1.70	2.36	4.17	6.18	2.87	2.92	2.89	1.94	3.64	—	2.33	2.36	—	1.18	2.66	—	1.36	1.31	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.00	.00	.00	.00	.00	.00	1.03	.00	.00	—	.00	.00	—	.00	.00	—	.00	.00	—
		24	.00	.00	.00	.00	.00	1.03	2.38	.00	.00	—	.00	.81	—	.00	.00	—	.00	.42	—
		32	.00	.00	.00	.00	1.03	2.38	4.07	.00	.00	—	.81	2.07	—	.00	.00	—	.42	1.52	—
12	4	40	.00	.00	.00	.00	2.38	4.07	5.88	.00	.00	—	2.07	3.65	—	.00	.00	—	1.52	2.89	—
		48	.00	.00	.00	.00	4.07	5.88	7.89	.00	.00	—	3.65	5.35	—	.00	.00	—	2.89	4.37	—
		56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	3.55	2.45	4.62	6.64	—	—	—	2.15	4.05	—	—	—	—	1.35	2.93	—	—	—	—
		24	4.68	3.49	5.51	7.11	—	—	—	2.92	4.77	—	—	—	—	1.80	3.39	—	—	—	—
		32	5.82	4.37	5.97	7.52	—	—	—	3.63	5.09	—	—	—	—	2.25	3.47	—	—	—	—
14	1	40	6.64	5.42	6.97	8.04	—	—	—	4.54	5.99	—	—	—	—	2.92	4.14	—	—	—	—
		48	7.42	5.92	6.99	8.07	—	—	—	4.94	5.87	—	—	—	—	3.09	3.82	—	—	—	—
		56	7.91	6.50	7.58	—	—	—	—	5.38	6.38	—	—	—	—	3.33	4.09	—	—	—	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	2.61	2.44	3.95	5.37	3.67	5.76	7.85	1.92	3.26	—	3.10	5.00	—	1.19	2.27	—	2.29	3.88	—
		24	3.31	3.25	4.67	5.67	5.06	7.15	8.82	2.56	3.78	—	4.30	6.15	—	1.57	2.56	—	3.18	4.76	—
		32	3.94	4.03	5.04	5.90	6.31	8.18	9.76	3.14	3.98	—	5.51	6.96	—	1.93	2.58	—	4.13	5.34	—
14	2	40	4.30	4.69	5.54	6.01	7.83	9.40	10.52	3.63	4.39	—	6.61	8.06	—	2.23	2.82	—	4.99	6.21	—
		48	4.58	5.26	5.73	6.11	9.12	10.24	11.33	4.11	4.45	—	7.78	8.72	—	2.54	2.74	—	5.93	6.67	—
		56	4.63	5.68	6.07	—	10.20	11.29	—	4.40	4.72	—	8.67	9.66	—	2.69	2.85	—	6.62	7.37	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	0.00	.14	1.30	2.05	5.06	6.56	7.97	.00	1.06	—	4.53	5.87	—	.00	.63	—	3.80	4.87	—
		24	.00	1.30	3.05	5.23	6.56	7.97	8.98	1.06	2.69	—	5.87	7.09	—	.63	2.03	—	4.87	5.87	—
		32	1.03	2.15	4.39	7.09	6.86	7.96	8.82	1.66	3.70	—	6.06	6.90	—	1.01	2.79	—	4.85	5.50	—
14	3	40	2.38	3.03	5.74	8.65	6.60	7.46	7.93	2.34	4.86	—	5.54	6.31	—	1.43	3.66	—	4.14	4.73	—
		48	4.07	4.05	6.94	10.20	7.77	6.24	6.62	3.18	5.81	—	4.62	4.96	—	1.97	4.29	—	3.05	3.25	—
		56	5.88	5.13	8.39	—	4.43	4.81	—	4.00	7.04	—	3.14	3.46	—	2.48	5.12	—	1.43	1.59	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	.00	.00	.00	.00	.19	1.38	3.18	—	—	—	—	—	—	.06	.00	—	.00	.63	—
		24	.00	.00	.00	.00	1.38	3.18	5.41	—	—	—	—	—	—	.00	.00	—	.63	2.03	—
		32	.00	.00	.00	.00	3.18	5.41	8.12	—	—	—	—	—	—	.00	.00	—	2.03	3.81	—
14	4	40	.00	.00	.00	.00	5.41	8.12	11.01	—	—	—	—	—	—	.00	.00	—	3.81	6.04	—
		48	.00	.00	.00	.00	8.12	11.01	14.27	—	—	—	—	—	—	.00	.00	—	6.04	8.36	—
		56	.00	.00	.00	.00	11.01	14.27	—	—	—	—	—	—	—	.00	.00	—	8.36	11.00	—
		64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		16	6.10	3.84	7.29	10.54	—	—	—	2.85	5.97	—	—	—	—	1.84	4.50	—	—	—	—
		24	8.17	5.22	8.67	11.10	—	—	—	3.90	6.95	—	—	—	—	2.43	5.08	—	—	—	—
		32	10.19	6.65	9.39	12.06	—	—	—	4.94	7.43	—	—	—	—	3.06	5.26	—	—	—	—
16	1	40	11.79	7.79	10.46	12.89	—	—	—	5.83	8.21	—	—	—	—	3.66	5.74	—	—	—	—
		48	13.34	8.91	10.84	12.78	—	—	—	6.65	8.38	—	—	—	—	4.18	5.65	—	—	—	—
		56	14.41	9.77	11.79	—	—	—	—	7.32	9.00	—	—	—	—	4.58	6.06	—	—	—	—
		64	15.49	10.64	—	—	—	—	—	7.92	—	—	—	—	—	4.99	—	—	—	—	—

CONTINUED

Table 17—Continued

DBH (inches)	Butt log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	4.89	3.56	6.26	8.85	5.04	8.50	11.95	2.63	5.04	—	4.05	7.18	—	1.68	3.69	—	3.04	5.71	—
		24	6.38	4.77	7.36	9.26	7.01	10.46	13.19	3.55	5.80	—	5.69	8.74	—	2.20	4.10	—	4.22	6.87	—
		32	7.74	6.01	7.90	9.65	9.10	11.84	14.51	4.44	6.13	—	7.39	9.88	—	2.75	4.18	—	5.52	7.71	—
16	2	40	8.69	6.95	8.69	9.77	10.88	13.56	15.49	5.18	6.68	—	8.93	11.30	—	3.22	4.48	—	6.75	8.83	—
		48	9.54	7.85	8.92	9.93	12.71	14.64	16.59	5.83	6.75	—	10.46	12.19	—	3.64	4.35	—	7.99	9.45	—
		56	9.96	8.56	9.50	—	14.22	16.16	—	6.33	7.14	—	11.76	13.45	—	3.93	4.59	—	9.03	10.51	—
		64	10.84	9.13	—	—	15.79	—	—	6.76	—	—	13.07	—	—	4.21	—	—	10.13	—	—
		16	14	1.43	3.47	6.32	8.30	11.02	13.60	1.04	2.86	—	7.38	9.80	—	0.63	2.20	—	6.44	8.44	—
		24	1.30	2.31	5.16	8.50	9.85	12.44	14.34	1.69	4.26	—	8.63	10.88	—	1.03	3.29	—	7.28	9.18	—
		32	3.05	3.41	6.75	10.74	10.69	12.59	14.34	2.51	5.58	—	9.13	10.82	—	1.54	4.29	—	7.43	8.87	—
16	3	40	5.23	4.57	8.57	12.71	10.41	12.16	13.23	3.40	7.06	—	8.64	10.15	—	2.11	5.41	—	6.69	7.95	—
		48	7.89	5.91	10.05	14.75	9.50	10.57	11.58	4.40	8.23	—	7.48	8.40	—	2.75	6.21	—	5.29	6.00	—
		56	10.70	7.23	11.93	—	7.76	8.76	—	5.41	9.72	—	5.59	6.40	—	3.40	7.33	—	3.19	3.85	—
		64	13.92	8.72	—	—	5.55	—	—	6.51	—	—	3.18	—	—	4.11	—	—	.63	—	—
		16	9.51	4.96	10.22	15.31	—	—	—	3.70	8.47	—	—	—	—	2.32	6.60	—	—	—	—
		24	12.84	6.89	11.98	16.23	—	—	—	5.14	9.82	—	—	—	—	3.27	7.40	—	—	—	—
		32	16.10	8.72	12.97	17.13	—	—	—	6.56	10.37	—	—	—	—	4.14	7.50	—	—	—	—
18	1	40	18.73	10.34	14.51	17.50	—	—	—	7.74	11.47	—	—	—	—	4.87	8.16	—	—	—	—
		48	21.30	11.94	14.93	17.86	—	—	—	8.91	11.65	—	—	—	—	5.59	8.00	—	—	—	—
		56	23.13	13.09	16.02	—	—	—	—	9.81	12.42	—	—	—	—	6.17	8.53	—	—	—	—
		64	24.98	14.17	—	—	—	—	—	10.57	—	—	—	—	—	6.68	—	—	—	—	—
		16	8.04	4.68	9.02	13.09	6.43	11.69	16.78	3.48	7.39	—	5.16	9.94	—	2.18	5.64	—	3.79	8.07	—
		24	10.65	6.43	10.49	13.69	9.08	14.17	18.42	4.79	8.48	—	7.33	12.02	—	3.03	6.22	—	5.47	9.59	—
		32	13.07	8.06	11.26	14.27	11.75	15.99	20.16	6.05	8.87	—	9.59	13.40	—	3.80	6.22	—	7.17	10.52	—
18	2	40	14.88	9.46	12.46	14.39	14.19	18.36	21.35	7.06	9.70	—	11.60	15.33	—	4.42	6.68	—	8.72	12.01	—
		48	16.54	10.81	12.73	14.51	16.70	19.69	22.62	8.04	9.76	—	13.67	16.41	—	5.02	6.48	—	10.35	12.77	—
		56	17.54	11.73	13.50	—	18.69	21.62	—	8.76	10.28	—	15.41	18.02	—	5.47	6.80	—	11.76	14.12	—
		64	18.47	12.57	—	—	20.68	—	—	9.34	—	—	17.08	—	—	5.86	—	—	13.19	—	—
		16	1.40	2.10	5.28	9.43	11.32	15.68	19.73	1.55	4.41	—	10.12	14.03	—	0.96	3.49	—	8.23	12.28	—
		24	3.35	3.32	7.48	12.23	13.72	17.78	20.98	2.46	6.28	—	12.08	15.77	—	1.53	4.94	—	10.33	13.52	—
		32	6.08	4.75	9.51	15.12	15.06	18.26	21.27	3.55	7.91	—	13.05	15.86	—	2.21	6.15	—	10.79	13.22	—
18	3	40	9.30	6.29	11.90	17.55	15.04	18.05	19.97	4.69	9.85	—	12.65	15.28	—	2.93	7.61	—	10.00	12.26	—
		48	13.16	8.04	13.69	19.99	14.19	16.11	17.89	5.99	11.27	—	11.42	13.14	—	3.75	8.57	—	8.40	9.86	—
		56	17.16	9.69	15.98	—	12.11	13.88	—	7.26	13.09	—	9.13	10.66	—	4.57	9.96	—	5.85	7.17	—
		64	21.70	11.44	—	—	9.34	—	—	8.55	—	—	6.11	—	—	5.42	—	—	2.63	—	—
		16	13.96	6.71	14.27	21.70	—	—	—	4.82	11.58	—	—	—	—	3.01	9.18	—	—	—	—
		24	18.99	9.23	16.67	22.95	—	—	—	6.54	13.36	—	—	—	—	4.14	10.21	—	—	—	—
		32	23.93	11.73	18.01	24.10	—	—	—	8.42	14.05	—	—	—	—	5.27	10.36	—	—	—	—
20	1	40	27.97	13.97	20.06	24.61	—	—	—	10.01	15.46	—	—	—	—	6.32	11.23	—	—	—	—
		48	31.94	16.10	20.65	25.04	—	—	—	11.49	15.62	—	—	—	—	7.27	10.92	—	—	—	—
		56	34.81	17.78	22.16	—	—	—	—	12.75	16.73	—	—	—	—	8.05	11.55	—	—	—	—
		64	37.63	19.35	—	—	—	—	—	13.91	—	—	—	—	—	8.74	—	—	—	—	—
		16	12.24	6.42	12.91	19.10	8.43	15.99	23.42	4.60	10.34	—	6.54	13.30	—	2.87	8.06	—	4.73	10.90	—
		24	16.39	8.76	14.96	19.97	11.84	19.28	25.56	6.20	11.82	—	9.15	15.97	—	3.91	8.85	—	6.75	12.82	—
		32	20.31	11.04	16.05	20.74	15.35	21.64	27.73	7.90	12.33	—	12.05	17.68	—	4.93	8.87	—	8.90	13.98	—
20	2	40	23.33	13.03	17.72	20.94	18.62	24.71	29.26	9.30	13.43	—	14.65	20.10	—	5.85	9.50	—	10.96	15.88	—
		48	26.16	14.89	18.11	21.08	21.88	26.43	30.81	10.59	13.47	—	17.27	21.40	—	6.67	9.14	—	13.04	16.70	—
		56	27.99	16.28	19.25	—	24.60	28.98	—	11.64	14.26	—	19.57	23.55	—	7.31	9.55	—	14.87	18.37	—
		64	29.67	17.57	—	—	27.30	—	—	12.58	—	—	21.86	—	—	7.86	—	—	16.69	—	—
		16	3.28	3.09	7.79	13.74	15.38	21.86	28.06	2.19	6.38	—	13.56	19.30	—	1.35	5.12	—	11.83	17.02	—
		24	6.31	4.75	10.70	17.33	18.83	25.02	30.04	3.34	8.78	—	16.27	21.89	—	2.08	6.98	—	13.98	18.92	—
		32	10.34	6.68	13.30	20.96	21.01	26.02	30.71	4.76	10.80	—	17.87	22.30	—	2.96	8.48	—	14.90	18.84	—
20	3	40	14.91	8.73	16.38	24.04	21.44	26.13	29.36	6.22	13.23	—	17.72	21.84	—	3.90	10.33	—	14.26	17.92	—
		48	20.32	10.98	18.63	27.05	20.73	23.96	26.92	7.82	14.91	—	16.44	19.31	—	4.93	11.43	—	12.51	14.98	—
		56	25.80	13.15	21.56	—	18.47	21.44	—	9.43	17.24	—	13.83	16.45	—	5.95	13.11	—	9.50	11.74	—
		64	31.91	15.45	—	—	15.33	—	—	11.13	—	—	10.34	—	—	7.00	—	—	5.63	—	—

		16	19.67	7.85	—	—	—	—	—	5.66	—	—	—	—	—	4.01	—	—	—	—	—
		24	26.82	10.95	21.05	29.67	—	—	—	7.91	17.27	—	—	—	—	5.57	14.24	—	—	—	—
		32	33.95	13.93	22.55	30.94	—	—	—	10.15	17.97	—	—	—	—	7.11	14.38	—	—	—	—
22	1	40	39.85	16.64	25.03	31.12	—	—	—	12.06	19.77	—	—	—	—	8.47	15.63	—	—	—	—
		48	45.66	19.22	25.31	31.31	—	—	—	13.96	19.42	—	—	—	—	9.82	14.97	—	—	—	—
		56	49.96	21.02	27.01	—	—	—	—	15.13	20.60	—	—	—	—	10.68	15.75	—	—	—	—
		64	54.18	22.79	—	—	—	—	—	16.38	—	—	—	—	—	11.53	—	—	—	—	—
		16	17.69	7.58	—	—	9.82	—	—	5.46	—	—	7.63	—	—	3.86	—	—	5.98	—	—
		24	23.81	10.49	19.16	26.29	13.96	24.07	32.68	7.58	15.55	—	10.92	20.29	—	5.32	12.67	—	8.58	17.25	—
		32	29.72	13.25	20.38	27.12	18.16	26.77	35.17	9.64	16.05	—	14.38	22.20	—	6.76	12.66	—	11.34	18.61	—
22	2	40	34.40	15.70	22.44	26.99	22.10	30.49	36.58	11.37	17.50	—	17.52	25.23	—	7.98	13.61	—	13.93	21.09	—
		48	38.83	18.00	22.55	26.87	26.05	32.14	38.14	13.06	17.07	—	20.79	26.25	—	9.17	12.92	—	16.65	21.80	—
		56	41.85	19.53	23.86	—	29.13	35.12	—	14.06	17.94	—	23.24	28.71	—	9.91	13.45	—	18.79	23.86	—
		64	44.68	21.03	—	—	32.29	—	—	15.11	—	—	25.88	—	—	10.62	—	—	21.03	—	—
		16	5.90	3.69	—	—	19.30	—	—	2.69	—	—	17.26	—	—	1.92	—	—	15.66	—	—
		24	10.33	5.67	13.63	22.33	23.96	32.64	39.76	4.14	11.52	—	21.05	29.03	—	2.94	9.81	—	18.80	26.14	—
		32	16.02	7.94	16.64	26.61	26.95	34.07	40.81	5.83	13.85	—	23.34	29.75	—	4.12	11.64	—	20.45	26.35	—
22	3	40	22.32	10.34	20.30	29.98	27.77	34.51	39.06	7.55	16.82	—	23.45	29.57	—	5.34	14.05	—	20.05	25.68	—
		48	29.67	12.96	22.63	33.29	27.17	31.71	36.04	9.47	18.42	—	22.22	26.24	—	6.71	15.21	—	18.34	22.09	—
		56	37.01	15.29	25.95	—	24.38	28.70	—	11.08	21.01	—	18.90	22.78	—	7.87	17.25	—	14.75	18.30	—
		64	45.14	17.81	—	—	20.56	—	—	12.87	—	—	14.65	—	—	9.11	—	—	10.16	—	—
		16	26.38	9.31	—	—	—	—	—	6.46	—	—	—	—	—	4.53	—	—	—	—	—
		24	36.21	13.01	—	—	—	—	—	9.12	—	—	—	—	—	6.35	—	—	—	—	—
		32	45.91	16.68	28.08	39.34	—	—	—	11.64	22.07	—	—	—	—	8.16	17.89	—	—	—	—
24	1	40	54.13	19.86	31.12	39.64	—	—	—	13.85	24.13	—	—	—	—	9.67	19.27	—	—	—	—
		48	62.13	23.11	31.63	40.04	—	—	—	16.12	23.84	—	—	—	—	11.27	18.46	—	—	—	—
		56	67.87	25.90	34.30	—	—	—	—	18.11	25.72	—	—	—	—	12.73	19.72	—	—	—	—
		64	73.51	28.66	—	—	—	—	—	20.08	—	—	—	—	—	14.08	—	—	—	—	—
		16	24.18	9.04	—	—	11.51	—	—	6.27	—	—	8.66	—	—	4.39	—	—	6.73	—	—
		24	32.81	12.54	—	—	16.42	—	—	8.77	—	—	12.52	—	—	6.11	—	—	9.76	—	—
		32	41.10	15.95	25.63	34.93	21.49	32.89	44.15	11.12	19.89	—	16.45	26.88	—	7.78	15.93	—	12.97	22.70	—
24	2	40	47.87	18.86	28.16	34.82	26.12	37.38	45.90	13.12	21.55	—	20.11	30.39	—	9.15	16.97	—	15.93	25.53	—
		48	54.26	21.77	28.43	34.80	30.99	39.51	47.91	15.15	21.11	—	24.00	31.72	—	10.58	16.08	—	19.14	26.34	—
		56	58.50	24.18	30.55	—	35.26	43.67	—	16.87	22.56	—	27.47	35.09	—	11.83	17.00	—	22.09	29.08	—
		64	62.53	26.52	—	—	39.64	—	—	18.53	—	—	31.06	—	—	12.97	—	—	25.06	—	—
		16	9.08	4.12	—	—	24.14	—	—	2.88	—	—	21.37	—	—	2.03	—	—	19.49	—	—
		24	15.24	6.41	—	—	30.11	—	—	4.51	—	—	26.34	—	—	3.16	—	—	23.68	—	—
		32	22.88	9.06	20.18	32.92	34.17	43.84	53.15	6.36	16.64	—	29.34	38.11	—	4.48	14.18	—	26.00	34.14	—
24	3	40	31.24	11.82	24.56	37.03	35.48	44.79	51.45	8.29	20.08	—	29.75	38.17	—	5.81	16.96	—	25.78	33.60	—
		48	40.82	14.98	27.45	41.17	35.21	41.86	48.23	10.50	22.05	—	28.59	34.55	—	7.38	18.30	—	24.01	29.52	—
		56	50.09	18.18	31.91	—	32.60	38.97	—	12.79	25.51	—	25.29	30.98	—	9.03	20.99	—	20.25	25.42	—
		64	60.29	21.70	—	—	28.76	—	—	15.30	—	—	20.77	—	—	10.78	—	—	15.21	—	—
		16	34.05	10.16	—	—	—	—	—	7.09	—	—	—	—	—	4.90	—	—	—	—	—
		24	46.98	14.24	—	—	—	—	—	9.92	—	—	—	—	—	6.95	—	—	—	—	—
		32	59.65	18.39	—	—	—	—	—	12.73	—	—	—	—	—	8.86	—	—	—	—	—
26	1	40	70.49	22.03	36.23	46.83	—	—	—	15.30	28.43	—	—	—	—	10.69	23.09	—	—	—	—
		48	81.19	25.53	36.13	46.70	—	—	—	17.74	27.58	—	—	—	—	12.39	21.66	—	—	—	—
		56	89.30	28.02	38.59	—	—	—	—	19.47	29.18	—	—	—	—	13.55	22.80	—	—	—	—
		64	97.29	30.59	—	—	—	—	—	21.18	—	—	—	—	—	14.81	—	—	—	—	—
		16	31.62	9.95	—	—	12.58	—	—	6.93	—	—	9.51	—	—	4.79	—	—	7.33	—	—
		24	43.18	13.86	—	—	18.05	—	—	9.64	—	—	13.73	—	—	6.74	—	—	10.75	—	—
		32	54.23	17.77	—	—	23.81	—	—	12.27	—	—	18.14	—	—	8.54	—	—	14.28	—	—
26	2	40	63.39	21.13	33.11	41.60	29.14	43.33	53.93	14.64	25.65	—	22.40	35.54	—	10.22	20.56	—	17.79	30.19	—
		48	72.19	24.31	32.80	41.04	34.53	45.13	55.70	16.85	24.67	—	26.73	36.57	—	11.76	19.07	—	21.39	30.66	—
		56	78.49	26.50	34.75	—	38.83	49.40	—	18.37	25.87	—	30.28	39.99	—	12.77	19.87	—	24.36	33.61	—
		64	84.51	28.73	—	—	43.38	—	—	19.85	—	—	33.97	—	—	13.85	—	—	27.59	—	—
		16	12.49	4.46	—	—	29.08	—	—	3.10	—	—	26.06	—	—	2.15	—	—	23.92	—	—
		24	20.56	6.93	—	—	36.48	—	—	4.82	—	—	32.26	—	—	3.37	—	—	29.36	—	—
		32	30.37	9.83	—	—	41.62	—	—	6.80	—	—	36.13	—	—	4.74	—	—	32.39	—	—
26	3	40	41.01	12.86	28.38	43.33	43.50	55.48	63.97	8.94	23.46	—	37.01	48.03	—	6.26	20.08	—	32.59	42.93	—
		48	53.21	16.18	31.13	47.63	43.29	51.77	60.02	11.26	25.32	—	35.83	43.64	—	7.89	21.29	—	30.74	38.05	—
		56	65.18	19.16	35.66	—	39.80	48.05	—	13.35	28.80	—	31.67	39.17	—	9.32	24.13	—	26.07	33.17	—
		64	78.37	22.47	—	—	34.86	—	—	15.61	—	—	25.98	—	—	10.95	—	—	19.99	—	—

CONTINUED

*U.S. GOVERNMENT PRINTING OFFICE: 1972-707-480/356

Table 17—Continued

D.b.h. (inches)	Butt log grade	Merchantable height (feet)	Initial value (dollars)	Vigor 1						Vigor 2						Vigor 3					
				No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—			No change in butt-log grade with height increase (feet) of—			Increase in butt-log grade with height increase (feet) of—		
				0	8	16	0	8	16	0	8	16	0	8	16	0	8	16	0	8	16
		16	42.42	12.13						7.92						5.55					
		24	58.68	16.98						11.24						7.77					
		32	74.73	21.92						14.41						10.09					
28	1	40	88.60	26.17						17.21						11.97					
		48	102.19	30.38						19.98						13.94					
		56	112.33	33.71						21.98						15.32					
		64	122.35	37.00						24.07						16.80					
		16	39.82	11.97						7.81						5.47					
		24	54.55	16.65						11.00						7.61					
		32	68.79	21.34						14.01						9.80					
28	2	40	80.74	25.33						16.63						11.56					
		48	92.16	29.21						19.18						13.37					
		56	100.25	32.19						20.96						14.59					
		64	108.01	35.09						22.80						15.87					
		16	16.16	5.40						3.52						2.46					
		24	26.24	8.32						5.50						3.80					
		32	38.44	11.73						7.71						5.40					
28	3	40	51.59	15.22						10.01						6.97					
		48	66.53	19.08						12.57						8.78					
		56	80.96	22.76						14.86						10.38					
		64	96.80	26.76						17.44						12.20					
		16	51.86	13.88						9.20						6.38					
		24	71.96	19.40						12.80						9.04					
		32	91.82	24.99						16.49						11.55					
30	1	40	108.99	30.11						19.90						13.96					
		48	125.84	35.55						23.52						16.46					
		56	138.43	39.89						26.66						18.55					
		64	150.87	44.20						29.53						20.63					
		16	49.13	13.77						9.12						6.32					
		24	67.56	19.13						12.61						8.89					
		32	85.42	24.50						16.15						11.30					
30	2	40	100.46	29.33						19.36						13.56					
		48	114.89	34.40						22.73						15.88					
		56	125.16	38.34						25.57						17.77					
		64	135.06	42.19						28.12						19.62					
		16	20.36	6.28						4.15						2.87					
		24	32.75	9.59						6.32						4.45					
		32	47.59	13.42						8.85						6.20					
30	3	40	63.45	17.48						11.55						8.11					
		48	81.40	22.21						14.71						10.31					
		56	98.59	26.73						17.91						12.48					
		64	117.43	31.65						21.22						14.85					

Injection of Benomyl into Elm, Oak, & Maple

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INJECTION OF BENOMYL INTO ELM, OAK, AND MAPLE

BENOMYL (methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate) is being widely investigated for its potential as a means of chemical control for various plant diseases. Efforts to protect trees from infection caused by vascular wilt pathogens, using this chemical, have met with limited success, but some critical problems have also been encountered.

The use of benomyl for prevention of or therapy for vascular tree diseases apparently requires that a biologically active form of the chemical or a derivative be distributed throughout the tree. Hock et al. (3) and Stipes (7) reported that benomyl applied as a soil drench to container-grown American elm seedlings prior to inoculation prevented Dutch elm disease symptoms and that the causal organism could not be reisolated. However, when benomyl was applied in this manner to field-grown American elms, differences in uptake, distribution of the fungitoxicant, and inhibition of disease symptoms were reported.

Biehn and Dimond (1) reported suppression of Dutch elm disease symptoms and fungitoxicant detection in field-grown American elms treated with a benomyl soil drench and subsequently inoculated. But Hock and Schreiber (2), following a similar procedure, found no symptom suppression and no detection of fungitoxicant. These conflicting results might be explained by differences in soil types.

The variable uptake of benomyl or its breakdown product, methyl 2-benzimidazolecarbamate, is only one of several problems associated with soil application. Effective treatment by soil application requires large amounts of benomyl. Much of this may be lost from the soil before it is utilized. The root zone of many trees in urban situations is inaccessible for this treatment method. Further, the heavy dosage required and the lack of control over subsequent movement of the chemical may be criticized as unacceptable contamination of the environment. Foliar applications, though not now known to be effective, might be similarly criticized.

Direct injection of benomyl into the tree would seem to offer many advantages and few of the drawbacks of soil applications. Hock and Schreiber (2) attempted to introduce an ethanolic suspension and an ethanolic solution of benomyl into elms through tubes inserted into the sapwood, but were unable to get much material into the trees. These applications did not suppress subsequent Dutch elm disease development, and bioassays did not detect the presence of fungitoxicant in the wood.

However, the development of an injection apparatus by Jones and Gregory (4) that permits injection of fluids under pressure into the outermost sapwood of trees and the solubilizing of benomyl reported by McWain and Gregory (5) suggested that the stem injection method of benomyl application holds considerable promise and should be further investigated. This paper reports the results of our initial trials using several benomyl solutions and the injection apparatus.

MATERIALS AND METHODS

Elms (Ulmus americana L.), oaks (Quercus velutina Lam.), Q. coccinea Muench., and Q. rubra L.), and maples (Acer saccharum Marsh.), 5 to 14 inches d.b.h., were injected in October and November at one, two, or four locations in the stem of each tree, 2 to 3 feet above the ground. Injection pressures ranged from 25 to 80 p.s.i., and the total volume injected per tree ranged from 80 to 4,000 milliliters.

Each of the following benomyl solutions were injected into several trees of each genus: 2.4-2.8 grams per liter of benomyl (50 WP) in 0.1N acetic acid; 2.5-3.2 grams per liter of benomyl (50 WP) in 50 percent aqueous ethyl alcohol; 3.0-4.4 grams per liter of benomyl (50 WP) in 0.5 or 1 N ammonium hydroxide; and 20 and 50 grams per liter of benomyl (50 WP) in 8.4 percent and 21 percent aqueous lactic acid, respectively.[1] In addition, a 13.3 grams per liter suspension of benomyl in water was injected into one red oak.

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[1]For details of solution preparation see citation (5).

The trees were sampled 1 to 3 weeks after injection. Branch tips were collected from eight locations in each tree--four from the upper crown and four from the lower crown--for bioassay of fungitoxicant. The bioassay procedure was as follows: Penicillium conidia were added to sterile liquid potato dextrose agar at 48 degrees C. to give 10,000 conidia per milliliters of PDA. The conidia and the agar were mixed briefly and then were poured into petri plates (about 30 milliliters per plate). When the Penicillium-seeded PDA had solidified, a 0.5-inch long section of branch tip was surface-sterilized or peeled of bark and embedded horizontally into the agar at the center of each plate. After 48 hours, average distance across the zone of inhibition was measured and recorded.

RESULTS AND DISCUSSION

All solutions were successfully injected in varying quantities into each of the tree species tested. Details of treatment and results for each tree, including solution injected, volume injected, benomyl content, time required, and bioassay results are listed in Table 1.

The time required to inject a given volume of fluid varied with the fluid, tree, tree species, and date of injection. Generally, the most fluid per unit time could be injected into oaks, followed closely by elm. Maples could be injected but at a considerably slower rate. Increased pressure resulted in more rapid uptake of all solutions.

Solution uptake and distribution were checked for red oaks injected in late September and mid-November. Injection rate for 0.5 percent azosulfamide dye in water was 5 to 10 minutes per liter per injection site in September and 10 to 15 minutes per liter per injection site in November.

Dye distribution was quite different for the 2 months. Two liters of dye injected into an 8-inch d.b.h. red oak on 30 September 1971 were immediately distributed throughout the tree in the current sapwood and leaves and at least in some roots. But 4 liters of dye injected into a 12-inch d.b.h. red oak on 18 November 1971 moved up the bole a maximum of

only 27 feet. Uptake of dye in elm and maple was not checked in September; but in November, it was not very rapid--less than 1 liter per injection site per hour. In elm, the dye moved up the bole a maximum of 15.5 feet; and in maple, it moved up only 8 feet. Hence, it appears that immediate distribution of injected fluids is affected by season of the year.

On the other hand, results of bioassays show that subsequent movement of fungitoxicant does occur, even in dormant trees. Some positive bioassays were obtained from oaks injected with all solutions except the ammonical solution and the aqueous suspension of benomyl. Only the lactic acid solution of benomyl gave any positive bioassays in elm and maple.

Although positive bioassays were not recorded for all trees or for all parts of trees injected with solutions of benomyl, it seems reasonable to suspect that further distribution of fungitoxicant will occur as growth resumes in the spring. Smalley (6) reported that at the time of inoculation, no positive bioassays could be obtained from wood of elms that had been treated with soil applications of benomyl; but that even so, significant protection from Dutch elm disease damage was provided. So it is also possible that the amount of fungitoxicant now distributed in the trees that we have treated may be ample to prevent vascular wilt infection.

Because considerable quantities of benomyl can be injected in relatively short periods of time into oaks, elms, and to a lesser extent into maples, it might be possible to protect trees from fungus-caused diseases, particularly vascular wilts. The positive bioassays obtained from some trees injected with solubilized benomyl strengthen this possibility.

Tree disease therapy may also be possible, particularly for diseases that do not envelop the entire tree immediately, such as oak wilt in white oaks, Dutch elm disease, and Verticillium wilt in maple.

The stem injection technique appears to have great advantages over soil applications or foliar sprays. Uptake of prescribed dosages is assured,

smaller quantities of the chemical are required, and its placement and subsequent movement are highly controlled. This is not only economically advantageous but also largely avoids the environmental pollution hazards associated with other methods of application.

Year-round treatment schedules, if called for, may be followed regardless of wind and rain and are limited only by very low temperatures. And this technique of injection need not be limited to solubilized benomyl but might be used for other systemic fungicides, insecticides, herbicides, and perhaps, even hormones and nutrients.

Results reported here have shown that quantities of solubilized benomyl can be injected into oaks, elms, and maples and that subsequent distribution within the tree occurs. However, much more research is required before the apparent potential of this technique for control of tree diseases can be realized. Inoculation studies must be completed to evaluate prophylactic and therapeutic properties of solubilized benomyl, possible phytotoxicity problems must be recognized and minimized, and optimal dosages, volumes, concentrations and treatment schedules must be determined. We believe that these problems can be resolved and that their solution will permit a major advance in our ability to cope with diseases of trees.

Table 1.--Treatment details and bioassay results for trees injected with benomyl

Tree no.	Tree species	D.b.h.	Number of injections*	Date injected	Total time for injection	Type of fluid injected	Total volume injected	Concentration of crude benomyl injected	Total crude benomyl injected	Date sampled for bioassay	Bioassay results: Zones of inhibition for branch tip samples							
											Upper crown				Lower crown			
											1:	2:	3:	4	1:	2:	3:	4
		In.		1971	Min.		ml	g/l	gm	1971	mm				mm			
1	*Quercus rubra*	14	4	10- 5	120	Aqueous suspension	565	13.35	7.5	10-14	0	0	0	0	4	0	0	0
1	*Ulmus americana*	8	2	10-18	315	50% aqueous ethanol	1290	3.2	4.1	10-27	0	0	0	0	0	0	0	0
2	*U. americana*	6	1	10-18	145	IN NH_4OH	150	3.2	.5	10-27	0	0	0	0	0	0	0	0
3	*U. americana*	6	2	10-19	20	0.1N acetic acid	1300	2.5	3.2	10-27	0	0	0	0	0	0	0	0
4	*Acer saccharum*	9	2	10-19	120	0.1N acetic acid	1240	2.4	3.0	10-27	0	0	0	0	0	0	0	0
5	*A. saccharum*	10	2	10-19	150	50% aqueous ethanol	750	3.2	2.4	10-27	0	0	0	0	0	0	0	0
6	*A. saccharum*	8	2	10-20	120	0.5N NH_4OH	80	4.4	.4	10-27	0	0	0	0	0	0	0	0
7	*Quercus velutina*	8	2	10-21	15	0.1N acetic acid	2000	2.8	5.6	11-10	0	0	0	0	12	11	10	6
8	*Q. velutina*	9	2	10-21	4	0.1N acetic acid	2000	2.8	5.6	11-10	0	0	0	0	0	0	0	0
9	*Q. coccinea*	7	2	10-21	11	50% aqueous ethanol	2000	2.5	5.0	11-10	14	12	11	13	12	7	10	16

10	*Q. coccinea*	10	2	10-21	7	50% aqueous ethanol	2000	2.5	5.0	11-10	5	0	0	0	0	0	5	0
11	*Q. rubra*	12	2	10-21	60	1N NH_4OH	1210	3.0	3.6	11-10	0	0	0	0	0	0	0	0
12	*Q. rubra*	7	2	10-21	4	1N NH_4OH	1800	3.1	5.6	11-10	0	0	0	0	0	0	0	0
13	*Q. rubra*	8	2	11- 9	60	21% lactic acid	500	50	25	11-22	8	0	5	0	5	9	2	8
14	*Q. rubra*	11	4	11- 9	120	21% lactic acid 8.4% lactic acid	500 1650	50 20	58	11-22	0	0	0	0	0	0	0	0
15	*Q. rubra*	9	4	11- 9	112	8.4% lactic acid	3340	20	67	11-22	0	0	0	0	0	8	0	5
16	*Ulmus americana*	8	4	11-12	90	8.4% lactic acid	2760	20	55	11-23	8	0	0	0	5	0	0	0
17	*U. americana*	5	2	11-12	16	8.4% lactic acid	1240	20	25	11-23	0	0	0	0	0	1	1	0
18	*U. americana*	6	2	11-12	45	8.4% lactic acid	2000	20	40	11-23	0	0	0	0	0	0	0	0
19	*Acer saccharum*	14	4	11-11	120	8.4% lactic acid	790	20	16	11-23	0	0	0	0	0	0	0	0
20	*A. saccharum*	12	4	11-15	125	8.4% lactic acid	770	20	15	11-23	0	0	0	0	0	0	0	0
21	*A. saccharum*	12	4	11-15	120	8.4% lactic acid	600	20	12	11-23	0	0	0	0	0	0	0	0
22	*Quercus rubra*	11	2	11-16	35	8.4% lactic acid	1200	20	24	11-22	1	0	0	1	0	0	0	0
23	*Q. rubra*	13	4	11-16	60	8.4% lactic acid	3000	20	60	11-22	0	0	0	0	0	0	0	0
24	*Q. rubra*	11	4	11-17	105	8.4% lactic acid	3000	20	60	11-22	0	0	0	0	0	0	0	0

*Injections for trees 1-9 made one at a time with one injector--injections for trees 10 to 24 made two at a time with two injectors operating simultaneously.

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Gregory, Garold F., Thomas W. Jones, and Percy McWain.
1971. Injection of benomyl into elm, oak, and maple. NE. Forest Exp. Sta., Upper Darby, Pa. 7 pp. (USDA Forest Serv. Res. Paper NE-232)

A newly devised apparatus using pressure to inject fluids into trees was used to inject solubilized benomyl into elms, oaks, and maples. In October and November, injections were made into the outer two annual rings of sapwood at points 2 to 3 feet above ground line. One to 3 weeks after injection, the trees were sampled; and positive bioassays were obtained from branch tips of some of the elms, oaks, and maples. Injection of benomyl into elms, oaks, and maples may provide protection from infection by fungal pathogens or may provide therapy for diseased trees.

Caution about Pesticides

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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An Apparatus for Pressure Injection of Solutions into Trees

by Thomas W. Jones
and Garold F. Gregory

USDA FOREST SERVICE RESEARCH PAPER NE-233
1971

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

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GAROLD F. GREGORY received a bachelor of science degree in agriculture from Kansas State University, a master's degree in plant physiology from Iowa State University, and a doctorate degree from Cornell University in plant pathology. He has been employed in forest disease research with the U.S. Forest Service since 1962. He is now a Principal Plant Pathologist at the Northeastern Forest Experiment Station's Forest Insect and Disease Laboratory in Delaware, Ohio.

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AN APPARATUS FOR PRESSURE INJECTION OF SOLUTIONS INTO TREES

We have devised an apparatus for injecting solutions under pressure into trees. This apparatus should permit rapid introduction of certain systemic fungicides, insecticides, herbicides, etc. directly into the xylem and should facilitate their distribution throughout the tree.

A unique and important feature of the apparatus is that solutions can be injected into the outermost xylem tissues. This is accomplished by feeding the solution under pressure through an injection head clamped against the surface of the sapwood to cover a small hole cut to penetrate the outer two or three annual rings. Rapid uptake and distribution of solutions is facilitated because maximum fluid movement occurs in the outer sapwood, and injected chemicals tend to move throughout the current wood and into the foliage and roots.

THE INJECTOR APPARATUS

The apparatus consists of the injection head attached to a small hydraulic jack, a belt to hold the apparatus in place on the tree, a gasket to provide a seal between the head and sapwood surface, a fluid supply hose with a valve near the injector head, a solution reservoir, a pressure regulator, and a supply of compressed gas.

The injection head (fig. 1) was machined from a steel rod 1 1/8 inches in diameter and 5 1/2 inches long. Half the length of the rod was turned down to about a 3/4-inch diameter so that it would fit snugly into a hydraulic jack, as described later. A centered hole, 5/8 inch in diameter by 2 1/4 inches deep, was drilled lengthwise into the rod from the large end.

A second hole, 7/16 inch in diameter, was drilled radially in the side of the rod 1 3/4 inches from the large end and deep enough to open into the bottom of the lengthwise hole. This second hole was threaded to accept a nominal 1/4-inch galvanized iron pipe that was 5 inches long. A 1/4-inch pipe union was attached to the pipe, a tapered hose fitting was screwed into the union, and the fluid supply hose was clamped onto the hose fitting.

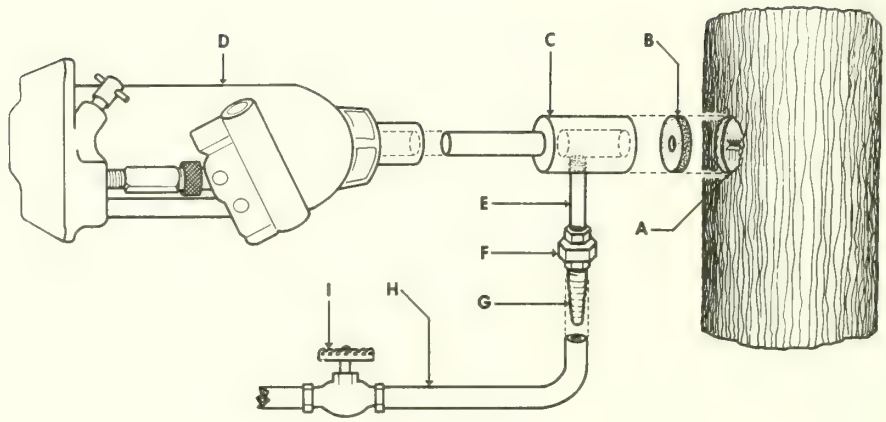


Figure 1.--The injector apparatus.

(A) Prepared injection site on tree with 1 3/8-inch-diameter hole cut through bark and wedge-shaped hole two or three annual rings deep.

(B) Neoprene gasket, 1-1/4 inches in diameter by 1/8 inch thick with 3/16 inch hole in center.

(C) Injector head machined from 1 1/8-inch steel rod 5 1/2 inches long; half the length of the rod turned down to fit into hydraulic jack; centered hole, 5/8 inch in diameter by 2 1/4 inches deep drilled lengthwise into rod from large end; second hole, 7/16 inch in diameter drilled radially in side of rod 1 3/4 inches from large end, deep enough to open into bottom of longitudinal hole and threaded to accept nominal 1/4-inch galvanized iron pipe.

(D) Hydraulic jack, 1 1/2 ton with threaded extension removed from ram.

(E) Galvanized iron pipe, nominal 1/4 inch by 5 inches long, threaded at both ends.

(F) Pipe union, 1/4 inch.

(G) Tapered hose fitting.

(H) Fluid supply hose from reservoir to injector head, 3/8-inch nylon reinforced clear polyvinyl chloride tubing

(I) Gate valve.

The threaded extension was removed from the ram of a 1 1/2-ton hydraulic jack, and the turned down end of the injection head was inserted in its place. The belt used to hold the injection apparatus in place was an automobile seat belt; the two halves were sewed firmly together to make a single belt with male and female buckle components at opposite ends. The round neoprene gasket, 1 1/4 inches in diameter by 1/8-inch thick with a 3/16-inch hole cut through the center, was used to seal the injector to the tree.

The 50-foot solution supply hose was 3/8-inch nylon reinforced clear polyvinyl chloride tubing of 225 p.s.i. test with a gate valve near the injector end. The fluid reservoir was a 2-foot section of 4-inch pipe with fittings at one end for connecting the fluid supply hose and with fittings at the other end for connecting the pressure source. As a pressure source, we first used a hand-pumped garden sprayer equipped with a pressure gage; but now we use a cylinder of compressed nitrogen equipped with a pressure regulator. Regulated air compressors should also be satisfactory.

USING THE INJECTOR APPARATUS

The procedure for using the injector apparatus is as follows: A round hole, about 1 3/8 inches in diameter, is cut at a convenient height--usually 2 to 3 feet above the ground--through the bark of the tree to be treated. We used a bow punch for this, but a chisel can also be used. To prevent leakage, it is important that all of the bark be removed but that none of the sapwood is cut.

In the center of the exposed sapwood, a wedge-shaped hole is cut by making a downward sloping cut and an upward sloping cut with a 1/2-inch chisel (fig. 2). The hole should be two or three annual rings deep. The neoprene gasket is placed in the hole in the bark. Next, the injector head with jack attached is placed into position with the belt passing across the base of the jack and around the tree (fig. 3). Then the injector head can be pressed firmly against the gasket by pumping the jack.

It is essential that the belt be adjusted up or down the tree to provide uniform pressure against the gasketed sapwood surface so that the jack does not tip up or down. This operation can be simplified by placing the injector on

Figure 2.--The prepared injection site.

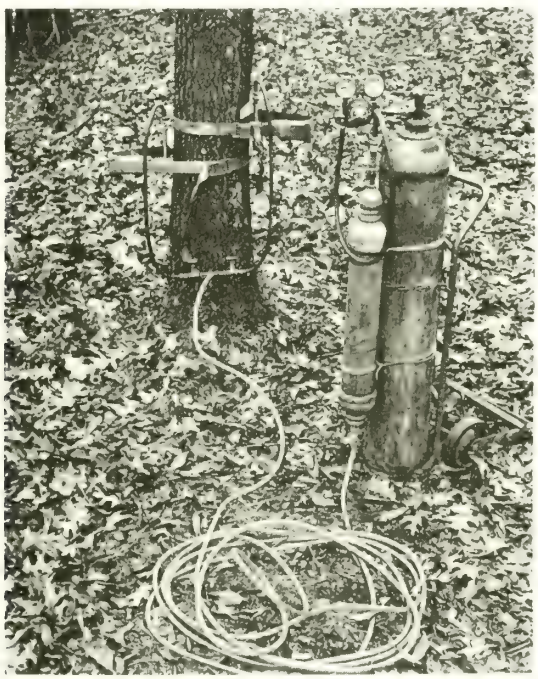
Figure 3.--The injector head in place.

the tree with the pipe to which the supply hose is attached pointing upward. The belt is adjusted so that the jack has a slight tendency to tip up when it is pumped. A wedge of wood inserted between the pipe and the tree will counteract this tendency, resulting in a secure installation.

The supply hose, with the valve closed, can now be loosely attached to the injector at the union. The solution to be injected is poured into the reservoir, the pressure source is connected, and a small amount of pressure is applied to the solution. The gate valve is opened slightly, allowing the solution to flow through the hose, thereby forcing out the air. When all the air has been expelled and the supply line and injection head are filled, the union is tightened, the valve is opened wide, and full injection pressure is applied to the solution (fig. 4). We have used up to 96 p.s.i. pressure without leakage, and we believe that higher pressures may be used if needed.

Movement of the last of the solution through the clear supply hose will indicate when injection is completed. Addition of a small quantity of soluble dye may be desirable for colorless solutions. The injection site should be coated with a tree wound dressing after the pressure injector is removed from the tree.

Figure 4.--The injection apparatus in use.



More than one injector can be connected to a single fluid reservoir. A manifold can be made at the end of the supply hose with tees and additional short lengths of tubing so that several injectors on a tree can be operated simultaneously. A separate shut-off valve for each injector is desirable.

We are now assembling several pressure injection units, each consisting of a small cylinder of compressed gas and lightweight plastic solution reservoir mounted on a packboard and equipped with four injectors. These will be extremely portable and will cost less than $200 each.

PERFORMANCE OF THE INJECTOR APPARATUS

We have used the injector apparatus to inject dye solutions and suspensions and solutions of benomyl fungicide into elms (*Ulmus americana* L.), oaks (*Quercus coccinea* Muench., *Q. rubra* L., and *Q. velutina* Lam.), and maples (*Acer saccharum* Marsh.).

A solution of azosulfamide dye in water (0.5 percent) was injected into red oaks in late September and in mid-November. Injection rate was 5 to 10 minutes per liter per injection site in September and was 10 to 15 minutes per liter per injection site in November.

Dye distribution was quite different on the two dates. Two liters of dye injected into an 8-inch d.b.h. red oak on 30 September 1971, were immediately distributed throughout the tree in the current sapwood and leaves and at least in some roots. In contrast, 4 liters of dye injected into a 12-inch d.b.h. red oak on 18 November 1971, moved up the bole a maximum of only 27 feet. Injection of dye in elm and maple was not checked in September; but in November, it was not very rapid--less than 1 liter per injection site per hour. In elm, the dye moved up the bole a maximum of 15.5 feet; and in maple, it moved up only 8 feet.

It has not been possible to inject very much benomyl suspension into trees. Apparently, the particulates clog vascular elements of the tree near the injection site. Our best result was injection of 565 milliliters of a 13.35 grams per liter suspension of benomyl in water into a red oak in 2 hours.

Benomyl solutions, on the other hand, have been readily injected into oak, elm, and to a lesser extent, into maple; and a subsequent movement of fungitoxicant into branches was detected.[1,2] Injection rate varied with the solution used and the tree species being treated; but 1 liter per injection site in 15 minutes in oaks, 1 liter per injection site in 30 minutes in elms, and 500 milliliters per injection site in 1 hour in maples are typical injection rates during the dormant season. More rapid injection and distribution of injected solution during the growing season are anticipated.

DISCUSSION

The apparatus we have devised provides an effective, simple, and economical means for putting solutions into trees. It should enhance the possibility of therapy for diseased trees and protection of trees from fungus infection with systemic fungicides. It might also be used with systemic insecticides, herbicides, and perhaps even hormones and nutrients.

Injecting pesticides or other chemicals directly into trees has many advantages over foliar spray or soil applications. Entry of prescribed dosages is assured, treatment schedules may be followed regardless of wind and rain, smaller quantities of chemical are required, and their placement and subsequent movement are highly controlled. Thus this method is not only economically advantageous, but also largely avoids the environmental pollution hazards inherent in other methods of application.

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[1]Gregory, Garold F., Thomas W. Jones, and Percy McWain. Injection of benomyl into elm, oak, and maple. USDA Forest Serv. Res. Paper NE-232, 9 pp. NE. Forest Exp. Sta., Upper Darby, Pa. 1971.

[2]McWain, Percy, and Garold F. Gregory. Solubilization of benomyl for xylem injection in vascular wilt disease control. USDA Forest Serv. Res. Paper NE-234, 6 pp. NE. Forest Exp. Sta., Upper Darby, Pa. 1971.

Jones, Thomas W., and Garold F. Gregory.
1971. An apparatus for pressure injection of solutions into trees. NE. Forest Exp. Sta., Upper Darby, Pa. 7 pp., illus. (USDA Forest Serv. Res. Paper NE-233)

The construction and use of an apparatus for injecting solutions under pressure into trees is described. A unique and important feature of the apparatus is that it permits injection of solutions into the outermost sapwood. It has been used to inject dye solutions and solubilized benomyl into elm, oak, and maple.

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Solubilization of Benomyl for Xylem Injection in Vascular Wilt Disease Control

by Percy McWain
and Garold F. Gregory

USDA FOREST SERVICE RESEARCH PAPER NE-234
1971

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

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GAROLD F. GREGORY received a bachelor of science degree in agriculture from Kansas State University, a master's degree in plant physiology from Iowa State University, and a doctorate degree from Cornell University in plant pathology. He has been employed in forest disease research with the U.S. Forest Service since 1962. He is now a Principal Plant Pathologist at the Northeastern Forest Experiment Station's Forest Insect and Disease Laboratory in Delaware, Ohio.

Manuscript received for publication 27 Dec. 1971.

SOLUBILIZATION OF BENOMYL FOR INJECTIONS INTO TREES FOR DISEASE CONTROL

The need for an effective systemic fungicide for plant pathogens has long been apparent. Foremost among several chemicals now being evaluated for their prophylactic and therapeutic properties is benomyl (methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate).

Several groups of scientists have tested benomyl for its potential in controlling Dutch elm disease (DED) (1,3,5). The chemical is usually applied to the soil in the root zone, with results ranging from fairly good protection to no protection. Most of these scientists recognize the need for a better means of getting the fungicide into trees. Smalley (5), in concluding his paper on soil application of benomyl to protect American elm from DED, states, "...a more effective means of introducing the chemical into elm trees needs to be discovered."

Hock and Schreiber (3) tried to feed benomyl in 50 percent aqueous ethyl alcohol into elms through tubes sealed into holes in the stem. They did not detect any fungitoxic material in bioassays of the young elm trees, so presumably no significant amounts were taken up.

We have used the pressurized system of fluid injection developed by Jones and Gregory (4) to introduce aqueous suspensions of benomyl fungicide into the two outer annual rings of *Acer saccharum*, *Ulmus americana*, and *Quercus rubra*. But only limited amounts of suspended benomyl could be injected, and these quantities did not move appreciably beyond the injection site.

The inability to inject significant amounts of suspended aqueous benomyl and the lack of significant uptake of alcoholic benomyl pointed out the need for solubilized benomyl that could be freely injected into trees. Desired solution characteristics are: solubility at relatively high concentration, solubility upon infinite dilution with water, low viscosity, adequate fungitoxicity, and little or no phytotoxicity. This paper reports our progress toward meeting these criteria.

EXPERIMENTAL

Benomyl (50WP) was added, in excess, to 95 percent ethyl alcohol, 50 percent ethyl alcohol, 1 N ammonium hydroxide, 0.1 N ammonium hydroxide, and 0.1 N acetic acid. The solutions were stirred for 1 to 2 hours at room temperature and were then clarified by filtration. All solutions were allowed to stand overnight and were refiltered if precipitate had formed. The 95 percent and 50 percent ethyl alcohol solutions deposited a relatively small amount of solute in standing whereas a considerable amount of solute was deposited from ammonium hydroxide solutions. Little or no deposition occurred from acetic acid.

The deposition from the various solutions undoubtedly altered the proportion of active benomyl to inert components, but bioassays showed that each solution remained highly fungitoxic. The solute concentrations of the filtrates determined gravimetrically ranged from 2.4 to 7.8 grams per liter (Table 1).

All these solutions had low viscosities. Benomyl in 0.1 N acetic acid, 1 N ammonium hydroxide, and 50 percent ethyl alcohol was not expected to be markedly phytotoxic in the amounts injected; and so it was selected for tree injection trials.

Additionally, solutions of higher concentration were obtained by treating benomyl (50 WP) with 91 percent acetic acid, 88 percent formic acid, hot 85 percent lactic acid, hot 42.5 percent lactic acid, and hot 10 percent aqueous gluconic acid. The solute concentrations obtained ranged from 10 to 380 grams per liter (Table 1).

Benomyl was added to these solutions with stirring; however, lactic acid and gluconic acid also required moderate heating. All solutions retained appreciable fungitoxicity. Only lactic and gluconic acid solutions could be diluted infinitely with water without forming precipitate, thus allowing the acids to be minimized in the solution for injection.

Of these concentrated solutions, benomyl solubilized in lactic acid seemed to be the most promising for injection into trees. The high concentrations of

this solution provided wide latitude for dilution with a minimum sacrifice of fungicide content.

The solution used for tree injection trials was prepared by adding 100 grams of benomyl (50 WP) to 1 liter of 42.5 percent lactic acid. The solution was heated and stirred until clear, diluted to 20 grams per liter with water, allowed to stand overnight, and filtered. This solution was nonviscous and remained essentially free of precipitate for more than a month. The addition of this solution to clarified red and bur oak leaf extract did not induce immediate or subsequent precipitation.

CONCLUSIONS

Varying amounts of benomyl have been solubilized in several solvents. This permits injection of the fungicide into trees for protection or therapeutic action against various fungal pathogens. Injection and distribution of some of these solutions in elms, oaks, and maples is reported in a concurrent article (2).

We believe that adequate amounts of fungicide for protection or therapy can be put into trees in this form without significant damage from the solvent, but this remains to be determined. Characteristics of the lactic acid solution make it the favored solution of the several prepared, but we are continuing research to find more desirable solutions of benomyl-derived fungitoxicant.

Table 1.--Solute concentrations from benomyl (50 WP) in various solvents

Solvent	Solute g/l
Water	0.75
95% ethyl alcohol	7.8
50% aqueous ethyl alcohol	3.5
0.1 N aqueous ammonium hydroxide	3.8
1.0 N aqueous ammonium hydroxide	6.8
0.1 N aqueous acetic acid	2.4
91% glacial acetic acid	48
88% formic acid	300
85% lactic acid (hot)	380
42.5% lactic acid (hot)	100
10% aqueous gluconic acid (hot)	10

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ACKNOWLEDGEMENT

The authors wish to thank E. I. du Pont de Nemours and Co., Wilmington, Delaware, for a generous supply of benomyl fungicide. Mention of a particular brand name does not imply endorsement by the Forest Service.

McWain, Percy and Garold F. Gregory.
1971. Solubilization of benomyl for injections into trees for disease control. NE. Forest Exp. Sta., Upper Darby, Pa.
6 pp. (USDA Forest Serv. Res. Paper NE-234)

Benomyl, in varying amounts, was solubilized in several solvents, thus allowing injection into trees for fungus disease prevention and therapy. A large amount of benomyl can be solubilized in diluted lactic acid. The resulting solution can be infinitely diluted with water without precipitation. These characteristics make it the current solution of choice for our tree injection studies.

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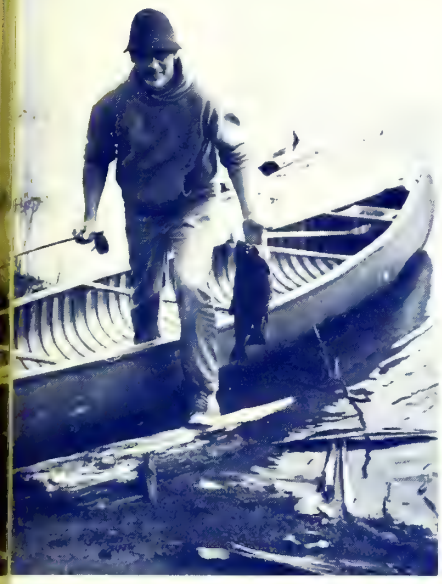

SUMMARY of the FOREST RECREATION SYMPOSIUM

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U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-235
1972
NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

FOREWORD

THOSE WHO ATTENDED the Forest Recreation Symposium held 12-14 October 1971 at Syracuse, New York, heard 26 papers about various aspects of forest recreation. Those papers have already been printed, in Proceedings made available at the Symposium, and also available upon request from the Northeastern Forest Experiment Station, 6816 Market Street, Upper Darby, Pa. 19082

This paper contains the welcoming remarks, the keynote address, the banquet speech, and a summary of the papers—thus completing the record of the Symposium.

SUMMARY of the FOREST RECREATION SYMPOSIUM

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WELCOMING REMARKS AT THE FOREST RECREATION SYMPOSIUM

by EDWARD E. PALMER, *President of the State University of New York College of Forestry at Syracuse, N. Y.*

A tribute to Robert Marshall, who contributed creative leadership to developing a greater understanding of the multiple use of forests —particularly the importance of wilderness areas for water and soil conservation and for essential ecological, recreational, aesthetic, and psychological needs.

IT IS INDEED a great pleasure and privilege to welcome the members of this Symposium this afternoon and to pay special tribute to the Pinchot Institute for Environmental Forestry Research and the U. S. Forest Service for inviting the College to join with them in the sponsorship of such critically important deliberation as that in which you will be engaged in the next few days.

I have had the honor of presiding over the administration of this College for the past 2 years, during which, as you can well imagine—since I have not even yet become a professional forester—I have engaged in a vigorous program of reading and studying about the profession and its responsibilities.

As I was pursuing a segment of that inquiry the other evening, I ran across frequent references to the work of Robert Marshall, the son of one of the principal founders of the College of Forestry here in Syracuse—Louis Marshall. As many of you know, Louis Marshall's memory is celebrated on our campus, where one of the principal buildings carries his name. It was he who drafted the legislation passed in 1911 creating the College which, I believe, for the first time, incorporated the broad ecosystem approach to forestry education, including recreation, more than 60 years ago.

Robert Marshall, his son, decided at the age of 15 to become a forester so that he might spend the greater part of his life in the woods he loved. He attended the New York State College of Forestry, was graduated in 1924, received his Master's degree from the Harvard Forest in 1925 and his Ph.D. from the Johns Hopkins Laboratory of Plant Physiology in 1930. He joined the U. S. Forest Service in the summer of 1924 and was on the staff of the Northern Rocky Mountain Forest Experiment Station from 1925 to 1928.

As Director of the Forestry Division of the U. S. Office of Indian Affairs from 1933 to 1937, Mr. Marshall helped to integrate the preservation and utilization of Indian forest lands into rebuilding tribal life on the principle of self government, and raising the level of living of the Indians. The U. S. Forest Service established the position of Chief of the Division of Recreation and Lands for Mr. Marshall in May 1937, and he occupied this post until his death in November 1939.

Perhaps Robert Marshall's greatest contribution was his creative leadership in developing a greater understanding of the

multiple use of forests–particularly the importance of wilderness areas for water and soil conservation and for essential ecological, recreational, aesthetic, and psychological needs.

In my own mind, as I welcome each of you to Syracuse, I at the same time celebrate Robert Marshall's early attempts to quantify and to evaluate forest recreation to get some real handles on a subjective experience tied closely to aesthetics, enjoyment, and thus the quality of human life. Although he said it in 1935 as a commentary on "Priorities in Forest Recreation," he perhaps set the stage well for a symposium of this kind when he worried the problem posed in the fact that:

"There are two worlds in which people may live today. The dominant one is the world of the 20th Century, with its great cities, its network of boulevards, its almost instantaneous means of communication, its inescapable machinery, and its high-speed, high-tension processes of life. It is the world which most of mankind chooses, and while some of us do not find it enough, we do not have the slightest missionary desire to lead others away from it. There is ample room in the United States for all those who want this world of the 20th Century, to enjoy it to their heart's content, and still leave a few nooks in the second world. It only demands a little planning, a little tolerance of a different mode of enjoyment, and some suppression of the dog-in-the-manger psychology.

"The second world does not date to any century, but only to the timelessness of the primeval.

"It is an impersonal world in which beauty has come into being without the slightest assistance from man.

"It is a subtle world in which great dramas of nature are enacted only for those who have the leisure and the patience of the primitive.

"It is a delicate world which is irreparably ruined by the slightest introduction of artificiality.

"It is a peaceful world in which the most instinctive yearnings are at home with environment.

"It is a world which to many of us contains the highest values in life.

"It is a world which can and must be used properly."

I derive some amusement out of comparing Robert Marshall with Henry David Thoreau both because the similarities between them are striking, and because so are the differences. Marshall's best-selling book, *Arctic Village*, ranks as an American classic along with *Walden*. Marshall had a deep love for the natural world and the strong confidence that the forests suggested the secrets of the good life. In these ways they are similar; but as Henry David Thoreau rejected society, social organization, and particularly governmental organization, Robert Marshall held high positions in public life and accepted the social governmental system on its own terms. He thus learned, as we must, to work with it and to obtain the best from it in the common interest. It occurred to me that some references to him and his work might not be inappropriate as a way of invoking the subject of your deliberations, in which I wish you all the best of luck and Godspeed!

■

KEYNOTE ADDRESS AT THE FOREST RECREATION SYMPOSIUM

by ALEXANDER ALDRICH, *Commissioner, Parks and Recreation, State of New York, Albany, N. Y.*

An outline of the recreation facilities and programs of the New York State park system, with suggested considerations for thought in planning and operating recreation facilities on both public and private lands.

A FEW WEEKS ago, I did not expect to be here today addressing you who are attending this Forest Recreation Symposium. Your keynote speaker was to have been Dr. Sal J. Prezioso, who until a few days ago was Commissioner of Parks and Recreation. However, Governor Rockefeller has asked Dr. Prezioso to assume new responsibilities as Commissioner of the Office for Local Government, and has asked me to assume the responsibilities as Commissioner of Parks and Recreation.

I am looking forward to this challenging responsibility of providing recreational opportunities for the 20 million people in New York State to the extent possible with the facilities provided by the State's park system.

WHAT THE STATE DOES

In its more than 40 years' existence, the New York State park system has been developed to include 215 thousand acres encompassing 128 parks from Montauk Point to Lake Erie and the St. Lawrence River. These parks can accommodate more than 700 thousand people at one time and provide such services as 36,632 picnic sites, 91 beaches, 22 swimming pools, 25 golf courses, 8,790 camp sites for tents or trailers, and 596 cabins.

Other services provide playgrounds for the small fry, small-game areas, adult game areas, and areas for strolling, resting, and viewing the scenery. Another area of endeavor is the operation of 33 State-owned historic sites where one may review and study the role of New York State in the Nation's development.

We also provide such services as the registration of motor boats, along with the very important education and training of junior operators and the placing of buoys as a safety operation for 15 interior New York lakes.

We have instituted a busing program, which brings inner-city youngsters and adults to the State parks for a day's outing or a day of supervised sports and recreation. This program has admirably served New York City, the Capital District, Rochester, Buffalo, and Syracuse. Two exceptionally successful ventures were the establishment of outdoor education centers in State parks to serve youngsters attending certain of the Syracuse public schools and students of 18 school districts in Suffolk County, whereby these children received excellent education in an outdoor natural area center.

The theme of the State parks' recreational-opportunities program is to provide a broad opportunity for its patrons to pursue almost any type of recreational experience they may desire. We have facilities of

high-intensity use, such as Jones Beach on Long Island; and we have the really remote camping sites, such as those in the peripheral area of the Adirondacks and in the central area of New York State. We have recreational opportunities to satisfy almost any interest.

Outdoor recreation has been thought for many years to be primarily a summer program; but with the development of new types of lightweight warm clothing, new types of camping equipment such as trailers and truck campers, and new types of vehicles such as snowmobiles, the demands on our park system for year-round recreation programs have become fantastic. People now visit our parks in the winter for camping, picnicking, snowshoeing, wildlife watching, skiing, snowmobiling, skating, ice fishing, hunting, and a myriad of other activities which are now considered enjoyable during the cold winter months.

SNOWMOBILING

A 1-year-old newcomer in our program of responsibility is the administration of the snowmobile law. In the first year, we have registered 144,000 snowmobiles. We forecast that we will reach a numerical plateau in about 5 years of some one-half million registrations. The first paragraph of the Snowmobile Law states:

> "It is the intent of this article to promote the safe and proper use of snowmobiles for recreation and commerce in this state by encouraging their use and development and minimizing detrimental effects of such use upon the environment."

We are interested in promoting safety and have recruited over 3,300 volunteer instructors to provide the required instruction to junior operators, aged 10 to 16.

Our first year's history of reported snowmobile accidents indicates a high percentage of head injuries, which leads us to believe that it may be necessary to institute a regulation requiring the wearing of safety helmets.

The snowmobile industry should change their emphasis on development from the horsepower race to a concern for public safety and the protection of our environment.

New York State law requires that snowmobile engine noise emissions be not greater than 82 decibels after June 1972 and not greater than 73 decibels after June 1974. The industry will meet this requirement. Industry has also lowered the oil-to-gasoline requirements to one part oil to 50 parts of gasoline, which will help to reduce air pollution. Must we stop at this point? Can we not reduce noise levels and air pollution much more?

The snowmobile industry should take the lead in this and in the more important consideration of improper impact on our environment from snowmobile use—the compaction of the soil with its resultant destruction of soil cover and eventual erosion through water runoff—the possible extirpation of forest growth—the destructive menace to wildlife.

Let's not sit still enjoying the immediate benefits of our technology, which created the snowmobile. Let's join hands to mitigate its destructive capabilities.

PRIVATE HELP

Your Symposium is to discuss forest recreation along with all of its attendant aspects. The State park system is quite familiar with forestry programs and forest recreation, as we have substantial forested land within our State parks. Probably the largest is that located in the Allegany State Park region. We also have heavily forested regions in the Taconic, Palisades, Central New York, and Finger Lakes areas. Many of our activities are associated with forest programs.

But let's look at some of the other types of forests throughout the State of New York. We have many and varied forests. We have the State forests, which are primarily areas of wornout farmlands that the State acquired and has replanted. Many of these areas are called reforestation areas. Their primary purpose is to demonstrate the capability of the soil and the geographical area to produce crops of wood products.

We also have large commercial wood-products forests. The Finch-Pruyn Lumber Company is the largest single owner of a commercial forest in New York State.

We have other types of forest land owners, such as the small woodlot owner, the farm woodlot owner, and the city person who has become affluent enough to be able to acquire some farmland that has been . . . well . . . possibly used up or possibly just tired . . . upon which he felt he must and should plant trees. He loves the growing things, but most important it's his—all his—and his alone. Never in his lifetime does he consider, and probably rightfully so, that there will be an opportunity to harvest a wood crop from these lands.

THE RECREATION EXPLOSION

Now let's take a look at forest recreation —the relationship of recreation to forests and the relationship of forests to recreation.

The interest of people in forest recreation has been exploding in this State at a tremendous rate. The State cannot keep pace with the demands and the needs for camping, hiking, fishing, hunting, bird watching, skiing, snowmobiling—you name it, it's there—we can't meet it.

An area of great interest to us in the State Park and Recreation Program is the encouragement of large private landowners who, as good citizens and good businessmen, will go into the recreation business.

In my judgment, no matter how fast we expand, the State park system cannot cope with the enormous demand for recreation across the State.

This means that, if the State needs parks, it needs partners who have the interest—who have the desire and the concern in providing a service to the citizens of the State. Forest recreation, as we've discovered, covers many things, and *it is compatible* with timber production.

You must recognize that there is nothing a recreating public can do on timber production land that will cause damage that cannot be prevented by control, exclusions, and management.

There are many and varied types of recreational pursuits in which the American public has an interest today. Consider the wide areas of interest and enterprise—hunting, fishing, hiking, skiing, snowmobiling, camping, bird watching, snowshoeing, boating, canoe trails, nature study, golfing, swimming, picnicking, horseback riding, games areas, and tot lots. Consider the economics and methods of operation.

In the matter of economics, it is necessary to consider three primary directive factors: (1) Do you desire to make a profit from the recreational facility; (2) Will you be happy with a "break-even" status?; Or (3) will you be willing to accept a financial loss in order to provide a public service as a public-spirited citizen?

In method of operations, you should consider a number of different types of program. One could be the owner-operated venture; and I think that discussion of owner operation can be assessed fully in the light of what I just mentioned about economic considerations.

A second choice would be a concession-type of operation, whereby the owner would either build the recreation facility and contract the operation to a concessionaire who would return to the owner a monetary dividend to pay off the first instance cost, with the concessionaire absorbing the cost of maintenance and operation and rehabilitation and, hopefully, making a profit. Or, he may elect to contract the construction and operation to a concessionaire on a long term or provide a write-off.

The third type would be the landowner's providing an easement to a government agency or to a private organization for the use of such land for recreational pursuit as may be in accord with the policy of the landowner.

CONCLUSION

A keynote speaker is supposed to set the tone of the meeting to follow. I have tried to make you aware of the many areas that the State park system has and is operating. I have also tried to give you some thoughts in reference to what could be done in areas other than State-owned lands. I have suggested considerations for thought in planning, economics, and methods of operation.

There are many other aspects in developing a well-rounded recreational facility upon which I have not touched. The keynoter is to present certain problems that he knows will be discussed along with many others in meetings of the program to follow. I hope that I have germinated some

thoughts and provided something for you to think about in your discussions for the rest of the day and at succeeding meetings.

I hope your meeting will provide sound thoughts for future recreational opportunities for all the many thousands upon thousands of people who have an interest in recreation.

■

CONSERVATION CONSIDERATIONS —A BOON TO OUTDOOR RECREATION

by PHILIP A. DOUGLAS, *Assistant to the Executive Director, National Wildlife Federation, Washington, D. C.*

Banquet address given at the Forest Recreation Symposium, Syracuse, N. Y., 13 October 1971.

SOCRATES WAS a Greek, a philosopher. He went about giving advice. They poisoned him.

In my remarks to you this evening I shan't repeat Socrates' mistake, though I hope I shall leave with you some concrete thoughts—many you've probably heard—to help us along in vital current programs to conserve our natural resources and, in keeping with the theme of this conference, to illustrate how these actions can aid us in providing, not just forest recreation, but various other phases of outdoor recreation.

I'm certain that your panel experts have covered the transition from pure fiber production by silviculture to multiple use, emphasizing the recreation potentials in our 508 million acres of commercial forest land and 250 million acres of private forest lands. My thoughts this evening will be along more general conservation lines—consummation of which will be a boon to outdoor recreation in all areas.

We must do all we can to foster more opportunity for outdoor recreation, particularly around water—a perpetual magnet to people, as are the forested public playgrounds. Our best planners estimate that by the year 1975 water-based recreation needs will have increased by 170 percent over what they were in 1960, and by 400 percent by the year 2000.

Every year, 9 out of 10 Americans—some 175 million—are on the move in search of outdoor recreation, places to fish, boat, picnic, swim, hunt, play, or just relax and enjoy fresh air and sunshine, generally close to water. 60 million of these will fish.

Those who despoil our waterways, in general, wear the black hats—the dam and road builders, nuclear- and hydro-power producers, irrigators, and the manufacturers of persistent and poisonous chemicals, the polluters by whatever means.

We in the natural resources conservation force, now to be reckoned with, very recently wore the white hats. Remember, this IS the Environmental Decade of 1970-1980.

BLACK HAT OR WHITE?

Now some strong and vigorously unscrupulous public-relations programs, in some cases by giving only half-truths, would put us under a black hat. They say:

—We don't want air conditioners and electric clothes dryers.

—We don't care who gets typhus or malaria, or that the spruce budworm is decimating our western forests.

—We don't want to travel smooth highways along scenic waterways; nor will we permit the people of Alaska to have road access to their new North Slope.

—We don't care about the farmer's need for water for his crops, with really no hope anyway to feed the geometrically expanding population growth.

But I say to you this evening, THE PEOPLE are deciding that THEY do want all of these things; and modern technology says that we safely can have most of them. IF we want to pay the piper. We can incorporate protection and safeguards for the natural environment in our original plans and design. AND at a price several recent surveys have shown we are willing to pay.

So isn't it really a matter of industry and conservation working TOGETHER at the very outset, rather than fighting a pitched battle after the fact?

We can have our water and drink it, boat on it, swim through it, and fish in it.

I feel that it is important at the outset to set up a series of definitions so that there are no misunderstandings. In my remarks, "conservation" means the wise use of the renewable natural resources. This differs from "preservation," which in my view precludes any use and implies a concerted effort to retain a natural resource in its original state —denied to most. Preservation is a retrogressive philosophy, because long-term retention in original condition is patently impossible in most cases.

Conservation practices are absolutely essential in many instances. One of the most-used examples involves the perpetuation of a deer herd. To accomplish this, a harvesting rate is established, based on optimum yield or what the range will produce and support in a healthy and productive condition. Hunters are allowed to crop off the surplus animals. With such practices as predator control, many of the deer's natural enemies are eliminated. The final outcome, if left to nature, would be starvation—a cruel fate. Protectionists have attacked this method of management; but do they proffer a better solution?

ENVIRONMENT AND ECOLOGY

President Nixon has pointed out the necessity to conserve our natural resources, particularly stressing a great need for restoration ". . . of the beauty of waterways and of air, and land which have been destroyed or virtually ruined by reason of our economic progress . . ."

So there is emphasis on restoration of the environment within the overall context of conservation. What do we mean by environment? "Environment" may be regarded as the sum total of our surroundings, made up of bits and pieces—air, soil, water, forests, grasslands, fish and wildlife, and open space; physical, biological, and chemical—whereas a counterterm, "Ecology," often misused, connotes the study of the relationships of organisms to each other within this composite environment.

The real crux of "conservation considerations" lies with many disrupting factors that affect the wise use of a renewable natural resource. My special expertise is in the conservation of aquatic resources and their essential ingredient, good-quality water.

One of the greatest problems confronting this Nation and the world today is the population expansion—explosion, if you will. A population of approximately 80 million in the United States in 1900 projected to the year 2000 could range between 280 and 310 million, with 80 percent in urban areas. For our natural water resources alone this means a tremendous overburden and an area of great concern to all of us for basic enjoyment, and some even say survival, of life. For instance, the future expansion of steam-electric power generation alone has placed a requirement for condenser cooling by the year 2000—if conventional once-through cooling procedures are employed—of 50 percent of the natural water runoff in the continguous 48 states.

There is an increasing demand involving a requirement for higher quality water. For example, we anticipate an additional 20 million anglers, a third more than we already have; but at the same time the demand for water will triple while the population doubles, due to increased per-capita use of water caused by increased urbanization, industrialization, rising levels of income, individual expectations, and increased leisure and outdoor recreation.

POLLUTION PARAMOUNT

Pollution control is paramount. Pollution may be regarded as being a specific impairment of quality to a degree that has an adverse effect upon any beneficial use. If

there is no impairment of use, then there is no pollution.

We are faced with much impairment. It is said that "Americans will contribute their share of 142 million tons of smoke and fumes, 7 million junked cars, 20 million tons of paper, 48 billion cans, and 26 million bottles to the environment each year. To run their air conditioners they will strip-mine a Kentucky hillside, push dirt and slate down into the stream, and burn coal in a power generator, whose smokestack contributes a plume of smoke massive enough to cause cloud seeding and premature precipitation from Gulf Winds which should be irrigating the wheat farms of Minnesota. In his lifetime, one American will personally pollute 3 million gallons of water, and industry and agriculture will use ten times this much in his behalf . . ."

A real problem exists for industry and large municipalities requiring at least secondary and, in some cases, tertiary waste treatment to comply with established water-quality standards. This requires substantial sums of money from both industry and government, and must encompass a defiinite involvement of state, county, city, local, and private segments of concerned organizations. Complete appropriation of authorizations, and the actual allocation of funds must be forthcoming under several clean-water acts now on the books, for the years to come until the job is done.

The President has stated that "The great question of the 70's is, shall we surrender to our surroundings or shall we make our peace with nature and begin to make reparations for the damage we have done to our air, our land, and our waters?"

CLEANING CAN HURT

A strange example illustrates an antithesis, where damage has been done to the aquatic environment by the Nation's effort to keep clean. Commercial laundries and home washing machines contribute to the detriment of the aquatic ecology in receiving waters. The so-called "hard" detergents exhibit high toxicity to fish. The more readily decomposable but more toxic "soft" detergents in minute concentrations, for instance, effect the ability of bullheads and bluegills to reproduce. Now we are learning that substitutes are caustic and can damage human tissue. There appears to be no solution to this problem as yet, and much confusion is aggravating the problem.

Municipal and industrial operations generate over 190 million tons of solid wastes annually, and this figure is expected to rise to 340 million tons at the end of this decade—great quantities finding their way to our waterways. Traditional disposal of municipal solid wastes by land-fill and incineration often results in pollution of land, water, and the atmosphere.

Of great concern to us is the Atomic Energy Commission forecast that approximately 111 nuclear powered steam-electric stations generating 84 million kilowatts of electricity will be built in the near future. These plants would require 170,000 cubic feet per second of cooling water, approximately the average flow of the Mississippi River at St. Louis, Missouri—a tremendous volume of water!

Of paramount concern is the heating effect on aquatic organisms—particularly in a confined area where there is no opportunity for adequate circulation and where natural temperatures are high. Heat has many side-effects on water quality, which affect aquatic life. Different species of fish require different temperatures at which they perform various activities at peak efficiency, at which they function inefficiently, and at which they die. With increased temperatures, the solubility of oxygen is decreased, and certain slimes and fungi flourish. Too, winter water temperatures must remain low enough to insure gradual growth of aquatic insects and provide food during protracted periods of emergence in the spring. Temperatures consistently at or above recommended limits place fish under stress, limit their scope of activity, and subsequently lower the fish's ability to compete for food and living space with other species that have greater heat tolerance.

THE ALASKA PIPELINE

Construction along waterways paralleling and traversing important fishery waters must be carefully planned and executed, such as the one much in the news today, the trans-Alaska pipeline system. Inasmuch as the present routing over the fragile Arctic by the 800-mile-long 4-foot hot-oil pipeline traverses and parallels many waters

between Prudhoe Bay and Valdez known to be productive of the important sport and commercial fisheries needs of Alaska, and with great potential for future natural resource needs of all America, great care must be exercised to prevent irreparable damage during some 175 crossings of various waterways. The Sagavanirktok River, for example, is traversed 32 times.

The timing of construction is important so that waterway sections are not disturbed during spawning and other migration periods of salmon and other species, and that gravel not be removed from areas where spawning normally takes place. It is estimated that over 13 million yards of gravel will be required for roads and stations alone, not to mention huge supportive requirements for the pipeline, landing strips, etc.

The Water Quality Improvement Act of 1970, P. L. 91-224, is providing some needed relief in establishing liability for the costs of clean-up of oil contamination from tankers and onshore and offshore loading of petroleum products, as well as fixing the responsibility for such oil spills. M. A. Wright, Humble Oil Company board chairman, stated during a recent meeting with conservationists and the Secretary of the Interior that better decision-making authority is needed by Government agencies on the local scene. This would permit immediate remedial action where an oil spill has taken place.

I am currently involved with working out response and research contingency plans to help prevent damage to our natural resources following an oil spill. I shudder to think about the many problems that could be encountered in transportation of oil from Prudhoe Bay via supertankers over 1,500 miles of foreboding ocean and sound to U. S. West Coast refineries. It would seem that this would set the stage for great oil-spill potentials. Conservationists are particularly concerned with overland transport because of the high frequency of earthquakes in the circum-Pacific seismic belt.

The Wild and Scenic Rivers Act of 1968 set aside certain waters designated in whole or part for perpetual free-flowing and undeveloped character—no dams! Generally, in these cases there are certain specific attributes that the waterway has that are unique and must be preserved. Currently, Americans are faced with hydropower development in the Columbia River Basin, which is seriously jeopardizing the Nation's irreplaceable remnant Pacific salmon and steelhead stocks. Gas-bubble disease, caused by supersaturation of nitrogen below spillways, is a real fish killer!

MORATORIUM ASKED

Specifically, conservationists have been fighting the power industry of the Northwest, as well as Federal dam builders who wish to construct several high dams on the Middle Snake and Salmon Rivers. These areas constitute the prime remaining spawning and nursery grounds of salmon and steelhead in the entire Columbia River Basin. Senators Frank Church and Len Jordan of Idaho have proposed a bill, S. 488, to declare a 7-year moratorium on dam-building in the Middle Snake River. This would provide a delay until resource agencies have a better opportunity to study and prepare alternate plans for needed power in this region of the country.

The National Wildlife Federation is currently working with the State Department, professional organizations, and the long-established International Commission for the Northwest Atlantic Fishery to solve problems of competition for Atlantic shelf fishes by foreign-flag fishing vessels. I cite here a current example: Atlantic salmon are being heavily harvested by Danish, Greenland, and Faroese drift-netters southwest of Greenland in Davis Strait. The vast majority of Atlantic salmon caught within these waters originate in spawning rivers outside Greenland, the largest proportion in Canada. Denmark voted against a moratorium during a 1970 conference of the 14 nations represented, refused to recognize the will of the majority, and established its 1970 and 1971 catch limits at the high point of 1969. Economic sanctions by other ICNAF member-nations may have to be applied to force compliance.

I believe the preceding gives ample evidence of what should not be done and what activities are detrimental to wise use and what is needed for the protection of the environment. The value of history is to show us the mistakes that have been made in the past. Our continued existence and

our well-being depend upon our working with nature, not against her.

Robert O. Anderson, chairman of the board and chief executive officer, Atlantic Richfield Company, said in a major public forum that we had better start shifting our sights from quantity to quality. An historic corner plainly has been turned. The cost to industry of environmental restoration appears very substantial. However, it must be borne in mind that industry will pass along most of this cost to its consumers, who appear to be determined to have adequate conservation of natural resources, whatever the cost will be.

SUMMATION OF THE FOREST RECREATION SYMPOSIUM

by PAUL F. GRAVES, *Professor, School of Environmental and Resource Management, State University of New York College of Forestery at Syracuse University, Syracuse, N. Y.*

A general summary of the Recreation Symposium held 12-14 October 1971 at Syracuse, N. Y., sponsored by the State University of New York College of Forestry, the USDA Forest Service, the National Recreation and Park Association, the New York State Office of Parks and Recreation, and the New York State Department of Environmental Conservation.

PURPOSE OF THE SYMPOSIUM

ONE OF THE REASONS for this conference is that the deepening public interest in and concern for environmental quality has given new dimension to the steadily expanding participation in forest recreation, bringing dynamic changes and unknowns that have led to both a sense of urgency and some feeling of frustration by those responsible for guiding development of resources in the proper directions. It no longer appears that the future can be readily predicted by simply extending past trends or using past criteria or standards. It is indeed timely that attention be given to the topics exposed here.

Major purposes of the Conference were to consolidate and evaluate our state of research understanding and managerial oversight for many of the current recreation-resource problems and to assess emerging new directions, needs, and concepts requiring cognizance in today's planning and in judgments toward the future. These purposes have been served rather well through the presentations and discussions of the 26 papers in the five sessions. The questions and participation by conferees have shown enthusiastic desire by all to get deeper insight into their functions and responsibilities, and to more fully meet their obligations to translate the recreation resource as meaningfully as possible into the dynamic public interest.

PLANNING AND DEVELOPING THE RECREATION RESOURCE

Reduced flexibility and other complications in planning are an outcome of the usual recreation-resource inventory process that does not clearly separate a mere inventory of resources from some built-in evaluation of them. Agency philosophy, social and political constraints, administrative needs, and personal values are all reflected in the standards and guidelines used for screening. This means that much planning judgment has been preempted in the data-gathering process, and in varying degrees a preformed development priority system has been initiated.

Prof. Davis criticized this prevalent approach for a number of serious shortcomings. By far the most important is the slower pace of change in natural resource complexes than in the dynamics of societal, political, and administrative conditions,

thereby making the inventory and the plans based upon it rather rapidly discordant with the setting in which they are expected to be useful.

A better approach suggested is to limit inventory standards to conditions and characteristics of the natural resources, which in turn requires definition of outdoor recreation activities to be served and some specification of quality for the recreation experience. From these data, a set of alternative development priorities can be woven into a plan with sufficient flexibility to meet changing societal needs and constraints.

While this revised inventory approach should certainly permit much better planning, it still would require guidelines or standards for defining quality and characteristics of recreational experiences. Man being what he is, these guidelines would seem inevitably to reflect the manager's or the researcher's cultural bias inasmuch as we have so very little useful knowledge of what constitutes quality of a user's experience.

Recognizing this, Prof. Davis suggested that perhaps the most important research needed is of this type—how people perceive their environment. We need to know much more about what a given recreational experience means to them if we are to plan suitably for providing it.

Dr. Shafer and Mr. Moeller also offered strong reasons for our getting quickly into better forecasts of the quality aspects of recreation use, as well as the usual quantity forecasts, even though it invades the battleground of natural sciences and social philosophies. Understanding of values and phenomena in this sector requires that recreation-resource managers and researchers be willing to change some of their present attitudes and research approaches.

Some methods already have been developed for predicting certain types of recreation values for specific management purposes, but very few managers have used the proven methodology because they find it difficult to act on estimates and uncertainty. They still prefer to trust their own intuition and judgment when planning ahead. Better information on the prove-out of these methodologies in real application would certainly increase their acceptance; but the future is now, and forecast experience is minimal. It is interesting that even the research authors based an evaluation of how useful an equation may be, for forecasting recreation use or amenity values, on past *research* efforts rather than on actual application and experience.

Numerous research results and predictive equations were offered and evaluated as to their potential utility for planning and forecasting, but the authors cautioned that much more exploration is needed on ways to forecast recreation values. While they spoke of using the qualitative values of an environment as part of a predictive model, they also noted that determining the best forest-recreation environment for man is extremely difficult. Qualitative recreation values involve such intangibles as security, beauty, freedom from stress, pleasant feelings, health, self-satisfaction, the psychological need for territory and status and recognition, and the amenities. Even if all of these can be measured with appropriate statistical reliability, one is inclined to sympathize with the doubt by some recreation managers that we will not forecast quality values very accurately until we can somehow cope with such powerful influences on recreational behavior as emotionalism, sentiment, irrationality, and unexplainable changes in public taste or mores. People's feelings are dynamic and constantly changing, hence unreliable as bases for forecasts.

It seems plausible to offer an observation here about other ideas to consider. We are faced by a fundamental dilemma, emphasized by the banquet address by Commissioner Aldrich: on the one hand, we have a population that will be 50 percent larger in 30 years, and a set of trends that clearly indicate a greatly disproportionate increase in outdoor recreation and other types of people participation with the resources of the land; on the other hand, the amount of land *available* to people for such participation is steadily decreasing, and the expectations of people for *quality* benefits from the land are rapidly increasing. Planning, forecasting, and research in recreation should start to give cognizance to the eventualities involved here. People-pressure alone can ultimately defeat the concept not only of wilderness, but of campgrounds, beaches, hiking trails, mountain climbing, hunting and fishing, and the very quality itself of

the forest recreation experience. Furthermore, the present condition of our environment indicates that our whole approach to resource use *must* change, and soon.

Perhaps the most reasonable ultimate solution to plan toward lies in a somewhat different vein than noted in the Conference papers. It could be thought of as having two major components:

1. Determine the true nature of individual and societal benefits and values derivable from quality experiences in recreation-resource uses, and then, using this knowledge, seeking out and developing feasible ways of substituting *other recreation* or *other human* experiences that offer comparable benefits and values in order to forestall strangulating pressures upon forest recreation resources;

2. Encourage and foster in every way possible a whole new ethic and philosophy toward resource uses by the public, aiming more at individual self-responsibility and service to society and *less* at the Benthamist philosophy of personal gratification and selfishness at others' expense. Such a change in philosophy should invalidate many of the trends and projections of forest recreation use that now threaten to destroy the quality that makes it valuable.

Relating somewhat to this concept, Prof. Fabos' critical analysis of the many new quantitative ranking systems that have been developed in recent years for measuring environmental qualities brought out other aspects of our developing state of knowledge for evaluating peoples' preferences and landscape qualities for support of planning and action. While also emphasizing the importance of being able to predict environmental *quality* values on various levels, as some of these systems may be able to do, he suggested that their greatest value may be to create new social norms for greater appreciation of environmental qualities. Here again, however, much more needs to be done toward making the existing ranking systems more valuable, and more and deeper research is needed in user preferences to provide a base of understanding for normative values that *should* be used in place of intuitive values in the ranking systems.

Quality also is emphasized through modification of recreation environments by design and layout to serve man's well-being as effectively as possible. Some recreation sites often receive more impact per visit than they can sustain, usually due to poor utilization of the recreation resource. This is frequently relievable in part by better design and layout. Mr. Lyons's discussion of a system for determining potential pedestrian impact described the numerous variables and their application as one useful tool for recreation facility design. However, until we know much more about how people perceive and benefit from the recreation environment, attempts to design either for sustainable carrying capacity or quality of user experience would seem to be made largely in the dark.

Dealing with a more mundane element of planning and development, Dr. Beardsley rather effectively shot down the popular promotive stance commonly taken by many government agencies and some economists that recreation development induces economic growth and substantial multiplier benefits, such as is usually the case with industrial development. His overview found that beneficial impacts from recreation are low compared to other economic sectors in local less-developed areas, especially when viewed from the standpoint of net gains and trade-offs for the larger economy. Even the probable local benefits that accrue from public investment in a large recreation reservoir must be reconciled against the priorities and opportunity costs, or benefits lost, to society from other uses of the funds that were foregone in building the reservoir. This sort of concern has become critical and preemptive under the climate of overdrawn government expenditures that has finally swept in upon us, under which the competition among high-priority public needs has become severe, and forceful examination of justification excludes many heretofore accepted proposals.

Sustained local economic growth not only is not enhanced, but on the contrary is often hindered where recreation-related spending is seasonal and is concentrated in a short period of the year, resulting in idle investments, loss of quality labor force, and heavy leakage of recreation income from the local area. We have seen the long-term

impacts of this condition in our Adirondack Region in New York State. Even the establishment of major national programs that are unable to overcome the seasonal characteristic of disutility, such as the Cape Cod National Seashore, makes little difference in local jobs, population, and tax income. Some disproportionate increases in local private land values do seem to occur, which is not necessarily good. One might observe that generally comparable impacts have been experienced locally from the St. Lawrence Seaway, which also is confined to seasonal use.

Mr. Lyons expressed hope in recent trends toward integrated year-round recreation communities. This would enable recreation enterprises to be conducted much more as efficient and sustainable business investments, with the stability that contributes to livelihoods, communities, and careers. At the same time, it could provide excellent promise as a cure for many of the maladies that Prof. Bevins found now afflict private recreation enterprises.

The relatively limited opportunity for financial success in the privately managed outdoor recreation business should be a cause for major concern to all of us. We should recognize that the great bulk of forest lands and their attractive outdoor recreation opportunities is in private ownership, and near at hand for the burgeoning metropolitan populations. Further, land costs have reached levels prohibitive for purchase to provide any sizable increases in public ownership, with the consequence that public forest recreation facilities cannot continue to sustain the pressures of use without ultimate loss of the qualities people seek. In the face of this impending crisis, however, public recreation managers still seem impelled to out-service and out-compete private efforts to serve recreationists on a business basis.

Recreational service pricing, Prof. Bevins brought out, is unrealistic and below operating costs. Obviously then, forest recreation cannot be kept solvent without subsidy. Why is this, if recreation is so valuable and in such demand? The reason seems to be that because public agencies historically made formerly little-used public lands available without charge, all outdoor recreation gradually came to be regarded as a service that the consumer expects to receive at a minimal price. This attitude has been conditioned over the years through public facilities being made ever bigger and more elaborate to meet user desires, always at much less than full-cost pricing. One could take the position, unpopular in today's setting, that this is patently inequitable. Perhaps more serious, however, are three other factors:

1. The basic rationale for forest recreation being provided by the public at heavily subsidized cost may not any longer be sound or defensible.

2. The best opportunities for providing whatever benefits are derivable from forest recreation to the urban populations likely needing it most, exist on privately owned lands relatively close-in and quickly accessible to cities.

3. Public recreation lands cannot indefinitely fulfill the enlarging interests of the American people in providing suitable quality recreational experiences. The much more abundant private forest recreation opportunities must be provided a healthy place in the scene, perhaps sooner than many public agencies care to consider, and such an ultimate goal should be made a part of recreation-resource planning and development.

MANAGING THE RECREATION RESOURCE

Because some of our most outstanding public recreation-resource assets depend for their quality and uniqueness upon preserving trees, and the prevailing ecological balance of the forest community, it is extremely important to management to understand the dynamic character of forested wilderness areas and parks and the likelihood of our failure in trying to preserve nature. Mr. Lime, speaking for Dr. Heinselman, offered convincing evidence that current management, with its strict protection both from the elemental forces of nature and from man's artificial substitutes, is not resulting in the preservation of nature. It may surprise many people that we are literally protecting these recreation resources to extinction, for under present management

concepts we are not providing for their recycling and natural ecological succession.

Ways must be found to restore and then manage the dynamic primeval environmental system as it lives and maintains itself, rather than trying to freeze it into a static mold. In this concept, we do not know how to manage them, and perhaps cannot do so. Feasible compromises between nature's way and man's management need to be spelled out in the form of specific ecosystem objectives, and then action should be taken to attain these objectives. Ecologist Heinselman expressed the view that only natural environmental forces should be used, particularly fires, insects and diseases, but not logging or professional forestry practices, which he feels are inconsistent with the preservation philosophy.

Whether he is correct or not, it seems difficult to believe that widespread public opinion would long accept deliberate burning of park or wilderness forests, which people surely would think a greater sin than the carefully managed clear-cutting of commercial timber that public sentiment has already condemned so vigorously, if ignorantly. Obviously *some* sort of management attention is needed, other than protection from destruction and from man tearing it apart, but there must be less risky and wasteful strategies that we can devise.

Wilderness, virgin forest conditions, and desirable qualities of the environment are "what we see them to be"—a frame of mind. Natural landscapes are of any age in most any location, and to many people wild forest land is any wooded place where the usual signs of man's habitation are not evident. Proper management of recreation resources requires that we understand much more than we do today about the processes and mechanisms of how man visualizes and perceives his environment.

Dr. Newby brought out the important concept that recreation resources must be *psychologically* accessible; that is, that individuals perceive much more in the recreational or esthetic experience if they are able to approach it with a conceptually receptive frame of mind or understanding.

His research also indicated, however, that perception depends as much upon complexity and order in the visual environment as it does upon the very important motivational and behavioral characteristics of the individual. This should give managers some assurance that their efforts can be significant in providing the qualities sought.

Another facet of perception is the value of external or largely unrealized benefits, such as "existence value" discussed by Dr. Tombaugh. He feels that these important values, which help keep the price system from working in the forest recreation field, do exist but are not yet fully understood or evaluated. Quite possibly many people feel that what he terms "existence value" may be thought of as being important because of many other reasons than recreation, such as watershed or open-space social values, sense of ownership and participation even though at a distance, strong sense of kinship to mankind, or simply a desire to do the "right thing," whatever societal sentiment indicates that that might be.

Management of the recreation resource increasingly requires reliable information about the user public as well as about the resource itself, and Mr. James' analysis of numerous inventory-sampling techniques dealt ably with the hard realities of assessing current conditions. All of these methods now available appear to need improvement; and as in other sectors of our concern, much remains to be done, particularly in reducing costs and increasing practical applicability. It might be interesting to observe here that as soon as we begin to really understand more about recreation benefits and peoples' quality perception of the environment, it is likely that most of our inventory approaches will be found inadequate.

Multiple-use management as applied on National Forest lands attempts to integrate recreation-resource management into the total complex of resource utility to society. It is fine in theory, but difficult and still largely unrealized in application. While, as Mr. Prausa noted, it comes down mostly to a management of conflicts, it is basically much more a set of people problems than of resource problems. For too long the Forest Service has tried to be all things to all people, especially in servicing user desires in outdoor recreation, to the point where many recreation-use desires themselves are in conflict. It is interesting to re-

lect on how this situation could have been permitted to come about in view of the basic purposes for which the National Forests in the East were acquired, but this is quite another component of constitutionality and Federal land management. As Mr. Prausa said, we must now recognize and "be concerned with the fact that full development of National forest lands and waters for recreation opportunities in the East may *not* be in the best public interest."

A crying need to make the multiple-use management concept work appears to be much better coordinated planning, both between the Forest Service and other landowners in regard to capabilities and interests, and among all the many purposes, including recreation on the lands for which the Forest Service is obligated to serve the public interest. Realistic goals and priorities must be developed and followed to assure that the *whole* public interest is being considered and aimed at, and not rationalized away to serve vociferous pressure groups and opportunism as demands are made and decisions reached.

Multiple-use management efforts can be so directed that maximum advantage of complementarity among functional objectives far exceed the benefits from single-purpose management. The optimum mix for complementarity is not static, and it also requires understanding and tolerance by the user public of the extent to which less than maximum dedication by the Forest Service to any one use is essential.

CHARACTERIZING THE RECREATION USER

The camper, as one of the major outdoor recreation user groups, was characterized in the overview by Dr. Cole and Dr. Wilkins as tending toward higher incomes than the average citizen, residing in suburban areas, having significantly higher levels of education, and being heavily represented in the professional-technical employment categories and other responsible positions. The camper tends to place extreme and increasing pressures upon public agencies to provide the facilities and sophistication in recreation areas that he has become accustomed to at home, and his reasons for camping are closely associated with extent and quality of facilities he expects to find. He prefers public-owned campgrounds because they have better facilities, are less expensive, and are better maintained.

A number of management implications are raised by the profile of campers, including the particular purposes for which public agencies supply camping opportunity. How far is it their responsibility to go in providing home-type facilities? What allocation mechanism will be acceptable for rationing use of well-developed areas? Is *attraction* of campers to public campgrounds appropriate? And to what extent is less-than-cost pricing of facilities and services to users a desirable policy? Differential pricing will likely become more necessary to regulate and balance uses between areas.

Hikers and trail users are a much less favored breed—the neglected outdoorsmen—as reported by Dr. Lucas. One reason seems to be their inconspicuousness and dispersal, with consequent lack of pressure and demand. The trail system seems to be declining slowly, with no national pressure for hiking opportunities outside wilderness areas. Hikers and trail users are predominantly younger people who seek esthetic values and contact with the natural environment rather than exercise or specific activities. Much of their need could readily be satisfied in a semi-wild setting, leading to the management implication that non-wilderness "trail recreation areas" could fill a real void and provide for hikers' needs better and cheaper than do wilderness trails. Diversity and variety are necessary, but the greatest need now is for day-use opportunity necessarily close to urban populations. There appears to be no reason why such trails need to be confined to public lands.

The phenomenon of recreation users articulating power and influence over public agencies through membership in highly organized clubs and groups is well recognized today. Their accomplishments are far out of proportion to their segment of the population. Dr. Hendee's synopsis indicated that they are urban-oriented, well above average in education, in income, and in occupational group. Their activism and multiple memberships are typical of other socially active interests today. Their numbers likely will increase *as a percentage* of total population in consonance with both rising educational levels and rising urbani-

zation. It is critical that public recreation-resource managers realize that members of conservation groups and outdoor clubs are not representative of all outdoor recreationists; Dr. Hendee estimated that less than 1 percent of recreationists hold such membership. Too often, especially of late, resource managers do consider such groups as being representative of all recreationists and probably give undue weight to their concerns. Further, this small fractional interest invariably presents its particular desires in such a way that it rationalizes or identifies them into the public interest. Public land managers should appreciate the value to them of the challenges being raised, but they seriously slight their obligations when they forget that the public interest is determined by all the people, not by a group or class seeking to speak for all.

Dr. Bond and Dr. Whittaker see a declining population of hunters and fishermen, despite the traditional free use of the resource base as the accepted norm. Motivations for hunting and fishing were found to be much more than killing game and catching fish, with a wide range of implications for resource managers, and with indications that privately managed hunting and fishing opportunities may fulfill needs for an increasing percentage of these recreationists in the future. Needed in-depth research into motivations may ultimately find possible substitute activities as well.

The characteristics and preferences of the skier as brought out by Dr. Leuschner indicate the overriding importance of locating ski areas near population centers, managing toward the preferences of the user, such as day-skiing, and providing ski-schools and varied ski slopes. There appears to be an excellent opportunity in this sector for *private* rather than public ski facilities to furnish the services sought by this user population, if permitted to do so without the competition of below-cost public ski enterprises. Ski touring also seems to offer good potential for offsetting excessive pressure on ski slopes.

The snowmobile, discussed by Mr. Hetherington, is probably with us to stay, judging from the heavy investment already made by over a million owners. Trail systems are available on both public and private lands, averaging some 50 miles in length. More are sought by snowmobile owners, but they are costly to develop ($100 to $150 per mile) and to maintain ($100 per mile per season). Public resource agency officials need to consider the potentially serious impact upon their existing primary-purpose programs that might well result from snowmobile accommodations they may enter into, especially since technological advances will continue to bring new types of outdoor vehicles into the natural recreation-resource setting. Also, an overall reading on where the public interest lies is provided by the array of snowmobile regulatory laws being enacted by the states.

SPECIFIC MANAGERIAL CONSIDERATIONS

Depreciative behavior of recreationists is a major managerial problem that we have not found a suitable solution to as yet. Mr. Clark, in studies in the State of Washington, found various reasons for such behavior and some hope for controlling it. Recreational sociology is changing as society as a whole does, and some heretofore standard rules designed to control recreational behavior need review and possible adjustment. Further standardization of rules and enforcement, and strengthening of the police powers of park authorities are suggested. But greater acceptance of responsibility by individual campers or development of a new ethic, is likely to reach more widespread and lasting results. Experiments in using anti-litter incentives have proven economical and surprisingly effective, offering considerable potential for managerial innovation.

Additional perspectives on law enforcement in recreation areas, discussed by Mr. Arthur for Mr. Hadley, also stressed that the changing nature of American society is causing millions of people to question the validity of some accepted traditions and values; and this philosophy carries over into park-user populations. He suggested that both the traditional functions and educational preparation of park personnel are unsuited to the emerging situations that demand involvement, especially law enforcement. Park managers must see that the law is up to date, and also use the law vigorously for control of hard crime, but make needed

nnovations in management programs that offer alternatives to law enforcement as the ultimate action. Considerable organizational and training actions have been taken by the Park Service to achieve an effective posture n law enforcement. As pressure of use continues to build up in public recreation areas, we in forest recreation will no doubt face similar behavior problems. It is essential that we as resource managers must develop the sociological insights suitable to enlightened human management in recreational settings.

Another aspect of the recreationist's behavior is how he thinks of the recreation resource and what it is that he wants to get from his experience there. Dr. Wagar's studies into the effectiveness of communicating and interpreting the meaning of the environment to recreationists showed that motivation and interest are generally low, and that considerable innovation, use of dynamic presentations, participation arrangements, and rewards for learning are required for success, all handled at quite a sophisticated level. Pre-programming with script, tape players, and orientation movies has been found to be very successful. Apparently the underlying need is to generate a sense of motivation and interest on the part of the recreationist. There are limitless opportunities for applying educational and teaching concepts here, but recreation managers may well question the validity of providing the recreational opportunity in the first place if the recreationist's interest requires this degree of electric prodding. On the other hand, perhaps with a little more such innovation, we could go all the way and move the resource to the people via TV.

An increasing problem of recreation managers is controlling carrying capacity at a level within which it is possible to maintain resource and recreation quality. Dr. Lime and Dr. Stankey defined the concept and offered many useful suggestions for those planning and managing recreational uses, involving either site management or modification of visitor behavior. Rotating use among available sites, or overdeveloping sites to permit non-use of one site for extended periods, are ways that carrying capacity can be spread and overused areas can be allowed to recuperate. But the variable carrying capacity of specific recreation areas depends on the site characteristics, the objectives for the area in question, and the user values involved. Often some determination must be made as to who shall be permitted to use, or not use, a particular site in order to hold numbers within necessary limits. Such action does little to enhance user satisfaction. However, there are still many ways to greatly increase the recreation load without damage to the resource, as illustrated by heavy use of some forest areas in Germany and France.

A specific illustration of the problems of managing for carrying capacity and rehabilitating overused sites was brought out by Prof. Ketchledge in describing research and restoration work on trails and alpine summit excessively trampled by hikers. His experience revealed the possible utility of a new dimension in site rehabilitation, that of involving the recreationists themselves in some aspects of overuse control and restoration. Its main value would appear to be its educational and corrective impact upon the behavior of recreationists as users.

LOOK AT THE RESEARCH TASK AHEAD

Recreation research and recreation-resource management have suffered severely from the cultural blinding, cultural myths, and similar cultural "fogweed" that Dr. LaPage and Dr. Lloyd so effectively uprooted for us. Outdoor recreation is an inseparable part of our culture and is a focal point for cultural clashes. Now that our whole American society is in the midst of change in some of its most important cultural values, basic changes are also appearing in the underlying precepts that have long supported planning, management, and research in outdoor recreation. The grand theories of perfect planning and neatly ordered systems do not fit the turmoil of reality. The challenge to recreation research is to recognize and avoid the many fictions, and get on with the important questions.

What are the important questions? They are many, and can be categorized in various ways. It seems to me that our most important and critical needs and challenges for research revolve around the *people* aspects of outdoor recreation. As Keith Arnold put

it 5 years ago at the National Conference on Policy Issues in Outdoor Recreation, "Federal outdoor recreation programs have been converted rapidly and dramatically from *resource oriented* byproducts of conservation and preservation to a *people-oriented* major public purpose." It is time we recognized that forest recreation is the *social* service of the forest and hence is far more a people problem than it is a forest problem.

As with the disorientation of current park rangers toward deviant behavior of recreationists, we have been perceiving the managerial needs and research tasks of forest recreation through the eyes of foresters and others with a resource-culture blindness. As a result, the great bulk of research conducted over the past decade and more has dealt with concerns over the resource base and with the pressing problems daily confronting resource managers. While this was initially necessary, it is time for us to begin to come to grips with underlying causes and realities, to try to elicit and assess the difficult concepts and facts necessary to intelligently determine the proper courses to pursue in recreation-resource use. There have been many illustrations during this conference of how handicapped we are without better basic information about the purposes we are serving and the appropriate methods for reaching public-interest goals.

We need to understand much better than we do what it is that human beings seek to satisfy through outdoor recreation, what are man's perceptions of a quality recreational environment, what motivates him to such participation. This is an extremely complex area, but is basic to policy judgments, to intelligent planning of both current and long-term programs, to determining potentially substitutable activities, and many similar practical considerations.

Another important question is the value of forest recreation to participants and through them to society and particularly to urban populations. What actual benefits accrue to both, what do we get out of it, how really important or necessary is it? As a corollary of this, there are certain assumptions that provide the basis for public subsidization of forest recreation for the public good that need serious examination of their validity in the light of experience to date. No doubt our recreation case has been built on several fictions that we can no longer afford to accept.

Meanwhile, those involved in managing recreation resources *must* respond to the burgeoning demands facing them and must make plans and investment decisions with whatever knowledge, experience, and intuition they can muster. They need the clairvoyance to see the future needs to be satisfied at a given time commitment, both in quality and amount. The important need here is for research to provide the resource manager with a sound basis for predictability that he will use in place of his own intuition. But such predictive outlook must somehow give full cognizance to the changes occurring in societal value systems and future life styles that will really call the tune on what people will be doing at future time of plan horizon.

The relationships that should pertain between public and private responsibilities in the American system for providing the best utility of forest recreation to the people must also be determined soon, and ways must be found to nurture and implement them. It is abundantly clear that public agencies cannot fulfill the public's expectations for quality recreational experience, nor are public recreation needs likely to compete at desired funding levels against other priority demands looming in future.

A somewhat more mundane question of critical importance in the research and management task ahead is to find ways to implement optimal multiple use or multiple-purpose management of public resources. Little real progress has been made in developing the dynamics of interrelated priorities, goals, optimal levels of use and complementarity, and user acceptance for the array of resource conditions that prevail. Public forest lands must serve the *whole* public, and we no longer can afford the luxury of preemptive commitment of major areas for any *particular* use.

This is only a brief glance at part of the research task ahead. There are many other important sectors, some no doubt much easier to handle, but these few I have mentioned may be sufficient to indicate the kinds of effort that seem important to me. Empirical studies and measurement of all kinds have tended to clutter the field of

ecreation research in the past, and they were necessary to meet needs of resource managers. But it is time now that we get into the complexity that actually controls where we should go and what we should be doing in resource use to establish the mutually compatible and beneficial relationships that must be made to endure between our people and our landed resources from here on out.

In concluding this conference, I think we have all been especially impressed with the magnitude of the problems and the opportunities and the responsibilities that we collectively share. At the same time, it is a great credit to the rather young field of concerted forest recreation and to those dedicated to the work going on within it that an enormous body of useful research and managerial expertise has been developed over the past decade or so. With the societal pressures upon all resources being already severe and sharply increasing, we need urgently to keep up the momentum of this great effort. In doing so, however, we must be ever mindful that momentum alone can throw us off some curve in the road ahead that we have not foreseen.

This has been a provocative and productive conference. It has been valuable in identifying and cross-communicating potential solutions for concerns of common interest, and thereby enhancing progress to the best of our present ability. But perhaps most important, this conference should also have impressed upon us the necessity for collective and joint action among many diverse interests and agencies concerned with outdoor recreation if we are to succeed in attaining the highest level of enlightened interactions for man with his natural environment.

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THE FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

Tree Condition and Mortality Following Defoliation by the *Gypsy Moth*

by Robert W. Campbell
and Harry T. Valentine

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NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

The trees by this house in Connecticut once provided wholesome greenery and shade. Now they are completely defoliated by the gypsy moth.

COVER PHOTO: A fully grown gypsy moth larva.

Tree Condition and Mortality Following Defoliation by the *Gypsy Moth*

The Authors

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INTRODUCTION

RELATIONSHIPS BETWEEN expected defoliation and the subsequent condition and mortality rate among the defoliated trees are almost always important factors in deciding if, when, and where to take control action against a defoliator such as the gypsy moth, *Porthetria dispar* (L.). Unfortunately, neither the after-defoliation condition of the trees nor their after-defoliation mortality rate have been predictable beforehand with a known degree of accuracy, and this has contributed to the uncertainty that has accompanied many control decisions in the past.

The objective of our work is to present a basis from which increasingly more accurate forecasting schemes can be developed for predicting both tree condition and mortality subsequent to defoliation. This basis, which is derived from a review of certain historical records, consists of a series of 323 tables giving both annual and cumulative tree-mortality rates, as well as the subsequent condition classes of the surviving trees, for particular tree species or species groups, and according to history of defoliation. These tables were prepared by sorting raw data from permanent plots. Like all such bases, they will have to be tested, and modified as necessary, to improve their predictive accuracy.

The records used here were taken between 1911 and 1931 by personnel of the now-defunct USDA Gypsy Moth Laboratory at Melrose Highlands, Massachusetts. They established 264 circular plots (0.18-acre) in 1911 and 1912 along the eastern seaboard of New England, from Wareham, Massachusetts, to Kennebunk, Maine. Within every plot, every tree over 3 inches in diameter at breast height (d.b.h.) was numbered; and the species, dominance class, and diameter class of each were recorded. Annual records were then maintained on defoliation and tree condition for each numbered tree. Although some of these records were lost, we have records for 14,266 trees.

Since the trees on most of the plots were stripped of their foliage two or more times between 1911 and 1922, and many were heavily defoliated for 2 years running, these records certainly reflect the most severe, widespread, *carefully documented* outbreak by this insect in North America. Although plots were established in a wide variety of forest stands, most of these stands were characterized by some species of oak (*Quercus spp.*) or gray birch (*Betula populifolia* Marsh.), and at least some red maple (*Acer rubrum* L.) and white pine (*Pinus strobus* L.).

Annual records were maintained through 1922 on 121 of the original 264 plots. Tree losses by the end of this 12-year period—averaged across these 121 plots—were 58 percent among white oak (*Quercus alba* L.), 55 percent among the gray birch, 46 percent among both black oak (*Quercus velutina* Lam.) and scarlet oak (*Quercus coccinea* Muench.), and 27 percent among red oak (*Quercus rubra* L.). Twenty-six percent of the white pine and 25 percent of the red maple also died. Within any given species, mortality rates tended to be highest among suppressed trees and lowest among dominant trees. Mortality rates were also consistently highest among trees classified in poor condition before heavy defoliation, and lowest among those classified as good.

Although species alteration due to gypsy moth activities was not documented directly, we infer from the records that these activities tended to accelerate the decline of pioneer gray birch stands, to reduce the ratio of white oak to red oak, and to increase the white pine component in mixed oak-white pine or gray birch-white pine stands. Ingrowth records, unfortunately, are not available; but this deficiency might be remedied by a careful study of current forest stands in this same general area.

PROCEDURE

The following independent variables were used in assembling the tables that follow:

1. Tree species.
2. Dominance class.
3. Diameter class.
4. Defoliation history.
5. Tree condition before defoliation.

First, the above records were sorted by species. Second, each species was separated into dominance classes: dominant, intermediate, or suppressed. Third, each dominance class was sorted by diameter class: d.b.h. less than 6 inches (class 1), or d.b.h. at least 6 inches (class 2). Fourth, the original defoliation records were sorted into two defoliation cate-

gories: less than 75 percent defoliation, or at least 75 percent defoliation.

These defoliation categories were chosen because most species of hardwood trees will refoliate a few weeks after defoliation by this insect if the original defoliation reaches 75 percent, and refoliation is thought to represent a major additional drain on the energy reserves of defoliated trees. (See Wargo, P. M., J. Parker, and D. R. Houston: STARCH CONTENT OF SUGAR MAPLE MAY INDICATE PHYSIOLOGICAL IMPACT OF DEFOLIATION; submitted to Forest Science, 1971.)

Fifth, the defoliation history of each tree was scanned across 1, 2, 3, or 5 years until one or more of the following histories was encountered (using the symbol H to represent at least 75 percent defoliation, and L to represent less than 75 percent): H, HH, HHH, LLH, HLH, LHH, LLLLL. For example, the history H represents a single known high-level defoliation preceded by an unknown pre-history, while the symbols LLH represent a single high-level defoliation preceded by two successive years when defoliation was known to be low.

These particular histories were chosen for three reasons. First, preliminary scanning of the data indicated that a 3-year defoliation history was adequate for characterizing subsequent tree mortality. For example, the consequences of the history HLLH were not consistently more severe, in terms of subsequent tree mortality, than the history LLLH. Second, the histories H and HH were chosen because they may enable the manager who knows specific defoliation histories for only 1 or 2 years to make better control decisions. Third, the history LLLLL was chosen because it reflects both subsequent condition and mortality among trees that had not been heavily defoliated for at least 5 years running.

Finally, when one of the first six defoliation histories was found, the tree was classed according to its condition (good, fair, or poor) in the fall of the year preceding the first high-level defoliation in that history. When the seventh defoliation history (LLLLL) was found, the tree was classed according to its condition in the fall of the fourth successive year of low defoliation.

We used two dependent variables: tree condition (good, fair, or poor); and tree mortality subsequent to defoliation. These values were tabulated for each year, from the fall of the year the defoliation history ended, year N, to year N+5—unless the tree died or further heavy defoliation was encountered.

Unfortunately we have not been able to locate a description of either the procedures the Melrose Laboratory workers used to estimate defoliation or their criteria for determining tree condition.

HOW TO READ THE TABLES

A portion of table 29 is reproduced below:

TABLE 29.

RED OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.6	33.6	9.8	0.0	0.0	122
N+1	55.6	17.8	15.6	11.1	11.1	90
N+2	64.4	11.9	15.3	8.5	18.6	59
N+3	60.0	27.5	7.5	5.0	22.7	40
N+4	69.4	19.4	11.1	0.0	22.7	36
N+5	66.7	15.2	15.2	3.0	25.1	33

122 observations were made on the immediate after-defoliation condition of suppressed red oak trees less than 6 inches d.b.h. and in good condition just before a single heavy defoliation. None of these trees died in year N, but only 56.6 percent of them were rated in good condition that fall, while 33.6 percent were judged to be in fair condition and 9.8 percent were classified poor.

Although no trees died in year N, only 90 of the original 122 trees remained in the records in year N+1, either because the 32 missing trees were again heavily defoliated in year N+1, or because their records were terminated because the plot was dropped or the study had ended. In any case, 11.1 percent of these 90 trees died in year N+1.

59 trees remained in the records by year N+2. Since 8.5 percent of these 59 trees died in year N+2, cumulative mortality for this stratum was calculated at 18.6 percent, using the formula:

$$\text{CumMort}_i = \text{CumMort}_{i-1} + (100. - \text{CumMort}_{i-1}) * (\text{Mort}_i) \qquad [1]$$

in which:

CumMort_i = Cumulative percent mortality by year i.
CumMort_{i-1} = Cumulative percent mortality by year $_{i-1}$.
Mort_i = Proportion dying in year i.

Finally, by year N+5, cumulative mortality had reached 25.1 percent, while the condition among the survivors, in this case, remained about the same as it had been in the fall of year N.

SUGGESTED USE OF THE TABLES

All the tables that follow reflect the unfortunate fact that the number of observations for any stratum was reduced considerably between years N and N+5. In practice, this means that the data base for long range (5-year) forecasts tends to be much less adequate than the base for short-range (1-year) forecasts, so the tables that follow have had to be constructed to cope, in part, with this problem.

We have assumed that users will want (1) information about the most specific category the basic data would allow, (2) across as many as 5 later years. Obviously there is no way of knowing the operational adequacy of these tables until they have been tested, but we have assumed that as few as 20 observations *might* yield a reasonably accurate forecast; so some of the tables that follow contain as few as 20 observations, even in year N. On the other hand, more general categories, which contain less specific information (for example, red oak instead of large dominant red oak) also contain more observations; and these more general tables may also prove to be useful. Finally, three extremely broad categories—mixed oak, food class B (edible, but not favored), and food class C (generally not eaten by this insect)—have also been tabulated because they contain the largest number of observations, albeit on very broad categories.

We suggest that prospective users should decide beforehand on the number of observations any given row in any given table must contain to be acceptable, and use the most specific table that meets this criterion. For example, the relevant table for large dominant white oaks might be adequate for years N and N+1, while the appropriate table for large dominant mixed oaks might be satisfactory for years N through N+3. One might have to use the appropriate table for unstratified white oaks for a satisfactory forecast through year N+4; and finally, the table for unstratified mixed oaks might have to be used for a forecast covering years N through N+5.

CAUTION. At first glance, one might suppose that our tables for trees within any given stratum that were exposed to little or no defoliation for 5 years running (LLLLL) would constitute a valid "control" against which to compare mortality rates and/or conditions for the same tree stratum that had been exposed to some more rigorous defoliation regime. This may not be true, because many of these trees represent survivorship from a preceding period of high-level defoliation and massive mortality. Thus these survivors may represent a sample biased toward defoliation resistance when compared to a more typical stand.

INDEX TO TABLES

Dominance class	Diameter (d.b.h) class (inches)	Defoliation history	Table No.
RED OAK (*Quercus rubra* L.)			
All	All	H	1
"	"	HH	2
"	"	HHH	3
"	"	LLH	4
"	"	HLH	5
"	"	LHH	6
"	"	LLLLL	7
Dominant	≤6	H	8
"	"	HH	9
"	"	LLH	10
"	"	LLLLL	11
"	>6	H	12
"	"	HH	13
"	"	LLH	14
"	"	HLH	15
"	"	LHH	16
"	"	LLLLL	17
Intermediate	≤6	H	18
"	"	HH	19
"	"	LLH	20
"	"	HLH	21
"	"	LHH	22
"	"	LLLLL	23
"	>6	H	24
"	"	HH	25
"	"	LLH	26
"	"	HLH	27
"	"	LLLLL	28
Suppressed	≤6	H	29
"	"	HH	30
"	"	LLH	31
"	"	LLLLL	32
BLACK OAK (*Quercus velutina* Lam.)			
All	All	H	33
"	"	HH	34
"	"	LLH	35
"	"	HLH	36
"	"	LHH	37
"	"	LLLLL	38
Dominant	≤6	H	39
"	"	LLH	40
"	"	HLH	41
"	"	LLLLL	42
"	>6	H	43
Dominant	>6	HH	44
"	"	LLH	45
"	"	HLH	46
"	"	LLLLL	47
Intermediate	≤6	H	48
"	"	HH	49
"	"	LLH	50
"	"	HLH	51
"	"	LLLLL	52
"	>6	H	53
"	"	HH	54
"	"	LLH	55
"	"	LLLLL	56
Suppressed	≤6	H	57
"	"	LLH	58
"	"	LLLLL	59
"	>6	H	60
SCARLET OAK (*Quercus coccinea* Muench.)			
All	All	H	61
"	"	HH	62
"	"	LLH	63
"	"	HLH	64
"	"	LHH	65
"	"	LLLLL	66
Dominant	≤6	H	67
"	"	LLH	68
"	"	HLH	69
"	"	LLLLL	70
"	>6	H	71
"	"	HH	72
"	"	LLH	73
"	"	LLLLL	74
Intermediate	≤6	H	75
"	"	LLH	76
"	"	HLH	77
"	"	LLLLL	78
"	>6	H	79
Suppressed	≤6	H	80
WHITE OAK (*Quercus alba* L.)			
All	All	H	81
"	"	HH	82
"	"	HHH	83
"	"	LLH	84

Dominance class	Diameter (d.b.h) class (inches)	Defoliation history	Table No.
All	All	HLH	85
"	"	LHH	86
"	"	LLLLL	87
Dominant	≤6	H	88
"	"	HH	89
"	"	LLH	90
"	"	LLLLL	91
"	>6	H	92
"	"	HH	93
"	"	HHH	94
"	"	LLH	95
"	"	HLH	96
"	"	LHH	97
"	"	LLLLL	98
Intermediate	≤6	H	99
"	"	HH	100
"	"	LLH	101
"	"	HLH	102
"	"	LLLLL	103
"	>6	H	104
"	"	HH	105
"	"	LLH	106
"	"	LLLLL	107
Suppressed	≤6	H	108
"	"	HH	109
"	"	LLH	110
"	"	LHH	111
"	"	LLLLL	112
"	>6	H	113
GRAY BIRCH (*Betula populifolia* Marsh.)			
All	All	H	114
"	"	HH	115
"	"	HHH	116
"	"	LLH	117
"	"	HLH	118
"	"	LHH	119
"	"	LLLLL	120
Dominant	≤6	H	121
"	"	HH	122
"	"	LLH	123
"	"	HLH	124
"	"	LHH	125
"	"	LLLLL	126
Intermediate	≤6	H	127
"	"	HH	128
"	"	LLH	129
"	"	HLH	130
"	"	LHH	131
"	"	LLLLL	132
Suppressed	≤6	H	133
"	"	LLH	134
"	"	LLLLL	135
PAPER BIRCH (*Betula papyrifera* Marsh.)			
All	All	H	136
"	"	LLH	137
"	"	LLLLL	138
Dominant	≤6	H	139
"	"	LLH	140
"	"	LLLLL	141
"	>6	H	142
"	"	LLH	143
"	"	LLLLL	144
Intermediate	≤6	H	145
"	"	LLH	146
"	"	LLLLL	147
RIVER BIRCH (*Betula nigra* L.)			
All	All	H	148
"	"	HLH	149
"	"	LLLLL	150
Dominant	>6	H	151
"	"	HLH	152
Intermediate	>6	H	153
"	"	HLH	154
ASPEN (*Populus spp.*)			
All	All	H	155
"	"	LLH	156
"	"	HLH	157
"	"	LLLLL	158
Dominant	≤6	H	159
"	"	LLH	160
"	>6	H	161
Intermediate	≤6	H	162
Suppressed	≤6	H	163
WILLOW (*Salix spp.*)			
All	All	H	164
"	"	HH	165
"	"	LLH	166
"	"	LHH	167
"	"	LLLLL	168
LINDEN (*Tilia americana* L.)			
All	All	H	169
"	"	LLH	170
"	"	LLLLL	171

Dominance class	Diameter (d.b.h) class (inches)	Defoliation history	Table No.
	LARCH (*Larix spp.*)		
All	All	H	172
"	"	LLH	173
"	"	LLLLL	174
Dominant	≤6	H	175
"	"	LLH	176
"	>6	H	177
"	"	LLH	178
"	"	LLLLL	179
Intermediate	≤6	H	180
"	"	LLH	181
"	"	LLLLL	182
	RED MAPLE (*Acer rubrum* L.)		
All	All	H	183
"	"	HH	184
"	"	HHH	185
"	"	LLH	186
"	"	HLH	187
"	"	LHH	188
"	"	LLLLL	189
Dominant	>6	H	190
"	"	LLH	191
"	"	LHH	192
"	"	LLLLL	193
Intermediate	≤6	H	194
"	"	HH	195
"	"	LLH	196
"	"	LHH	197
"	"	LLLLL	198
"	>6	H	199
"	"	LLH	200
"	"	LLLLL	201
Suppressed	≤6	H	202
"	"	HH	203
"	"	LLH	204
"	"	LHH	205
"	"	LLLLL	206
	WHITE PINE (*Pinus strobus* L.)		
All	All	H	207
"	"	LLH	208
"	"	LLLLL	209
Dominant	>6	H	210
"	"	LLH	211
"	"	LLLLL	212
Intermediate	≤6	H	213
"	"	LLLLL	214
"	>6	H	215
Intermediate	>6	LLH	216
"	"	LLLLL	217
Suppressed	≤6	H	218
"	"	LLH	219
"	"	LLLLL	220
	HICKORY (*Carya spp.*)		
All	All	H	221
"	"	LLH	222
"	"	LLLLL	223
	AMERICAN BEECH (*Fagus grandifolia* Ehrh.)		
All	All	H	224
"	"	LLH	225
"	"	LLLLL	226
	MIXED OAKS		
All	All	H	227
"	"	HH	228
"	"	HHH	229
"	"	LLH	230
"	"	HLH	231
"	"	LHH	232
"	"	LLLLL	233
Dominant	≤6	H	234
"	"	HH	235
"	"	LLH	236
"	"	HLH	237
"	"	LHH	238
"	"	LLLLL	239
"	>6	H	240
"	"	HH	241
"	"	HHH	242
"	"	LLH	243
"	"	HLH	244
"	6	LHH	245
"	"	LLLLL	246
Intermediate	≤6	H	247
"	"	HH	248
"	"	HHH	249
"	"	LLH	250
"	"	HLH	251
"	"	LHH	252
"	"	LLLLL	253
"	>6	H	254
"	"	HH	255
"	"	LLH	256
"	"	HLH	257
"	"	LHH	258
"	"	LLLLL	259

Dominance class	*Diameter (d.b.h) class (inches)*	*Defoliation history*	*Table No.*
Suppressed	≤6	H	260
”	”	HH	261
”	”	LLH	262
”	”	HLH	263
”	”	LHH	264
”	”	LLLLL	265
”	>6	H	266
”	”	LLH	267
”	”	LLLLL	268
	FOOD CLASS B		
All	All	H	269
”	”	HH	270
”	”	HHH	271
”	”	LLH	272
”	”	HLH	273
”	”	LHH	274
”	”	LLLLL	275
Dominant	≤6	H	276
”	”	LLH	277
”	”	LLLLL	278
”	>6	H	279
”	”	HH	280
”	”	LLH	281
”	”	HLH	282
”	”	LHH	283
”	”	LLLLL	284
Intermediate	≤6	H	285
”	”	HH	286
”	”	LLH	287
”	”	HLH	288
”	”	LHH	289
”	”	LLLLL	290
”	>6	H	291
Intermediate	>6	HH	292
”	”	LLH	293
”	”	HLH	294
”	”	LHH	295
”	”	LLLLL	296
Suppressed	≤6	H	297
”	”	HH	298
”	”	LLH	299
”	”	LHH	300
”	”	LLLLL	301
”	>6	H	302
”	”	LLH	303
”	”	LLLLL	304
	FOOD CLASS C		
All	All	H	305
”	”	LLH	306
”	”	HLH	307
”	”	LLLLL	308
Dominant	≤6	H	309
”	”	LLH	310
”	”	LLLLL	311
”	>6	H	312
”	”	LLH	313
”	”	HLH	314
”	”	LLLLL	315
Intermediate	≤6	H	316
”	”	LLH	317
”	”	LLLLL	318
”	>6	H	319
”	”	HLH	320
”	”	LLLLL	321
Suppressed	6	H	322
”	”	LLLLL	323

TREE DEFOLIATION TABLES

TABLE 1.

RED OAK

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	25.9	7.2	0.2	0.2	1311
N+1	68.3	18.2	9.4	4.1	4.3	923
N+2	74.0	15.1	9.1	1.8	6.1	724
N+3	69.8	20.2	8.7	1.2	7.2	480
N+4	72.1	18.5	9.0	0.5	7.7	433
N+5	73.4	16.5	9.8	0.3	7.9	369
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.2	47.0	32.8	1.0	1.0	402
N+1	19.7	28.3	35.9	16.2	17.0	290
N+2	20.6	29.7	43.0	6.7	22.6	165
N+3	29.9	28.4	40.3	1.5	23.7	67
N+4	29.1	32.7	32.7	5.5	27.9	55
N+5	35.6	28.9	35.6	0.0	27.9	45
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.2	7.3	90.6	0.8	0.8	245
N+1	1.4	4.2	66.2	28.2	28.8	142
N+2	1.6	1.6	79.4	17.5	41.2	63
N+3	0.0	8.0	76.0	16.0	50.6	25
N+4	0.0	25.0	68.8	6.3	53.7	16
N+5	16.7	16.7	66.7	0.0	53.7	12

TABLE 2.

RED OAK

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.9	28.6	19.3	1.1	1.1	269
N+1	63.3	12.0	12.0	12.7	13.6	158
N+2	75.0	4.5	18.8	1.8	15.2	112
N+3	71.7	8.7	17.4	2.2	17.0	46
N+4	75.7	13.5	8.1	2.7	19.3	37
N+5	80.0	10.0	10.0	0.0	19.3	30
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.7	18.2	67.3	1.8	1.8	55
N+1	16.7	11.1	27.8	44.4	45.5	36
N+2	33.3	0.0	55.6	11.1	51.5	9
N+3	66.7	0.0	33.3	0.0	51.5	3
N+4	33.3	33.3	33.3	0.0	51.5	3
N+5	0.0	100.0	0.0	0.0	51.5	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.7	2.7	94.6	0.0	0.0	37
N+1	3.6	0.0	75.0	21.4	21.4	28
N+2	0.0	0.0	40.0	60.0	68.6	5
N+3	0.0	0.0	100.0	0.0	68.6	1
N+4	0.0	0.0	100.0	0.0	68.6	1
N+5	0.0	0.0	100.0	0.0	68.6	1

TABLE 3.

RED OAK

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	11.8	23.5	61.8	2.9	2.9	34
N+1	5.6	16.7	61.1	16.7	19.1	18
N+2	14.3	0.0	85.7	0.0	19.1	7
N+3	25.0	0.0	75.0	0.0	19.1	4
N+4	50.0	0.0	50.0	0.0	19.1	2
N+5	50.0	0.0	50.0	0.0	19.1	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	0.0	83.3	0.0	0.0	6
N+1	0.0	0.0	33.3	66.7	66.7	3
N+2	0.0	0.0	100.0	0.0	66.7	1
N+3	0.0	0.0	100.0	0.0	66.7	1
N+4	0.0	0.0	100.0	0.0	66.7	1
N+5	0.0	0.0	0.0	0.0	66.7	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	33.3	66.7	66.7	3
N+2	0.0	0.0	0.0	0.0	66.7	0
N+3	0.0	0.0	0.0	0.0	66.7	0
N+4	0.0	0.0	0.0	0.0	66.7	0
N+5	0.0	0.0	0.0	0.0	66.7	0

TABLE 4.

RED OAK

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	83.4	14.5	2.0	0.0	0.0	488
N+1	74.6	17.1	7.6	0.7	0.7	410
N+2	72.2	19.1	7.9	0.8	1.5	367
N+3	71.7	18.5	8.3	1.5	3.0	265
N+4	69.3	21.6	8.7	0.5	3.5	218
N+5	66.7	24.0	9.3	0.0	3.5	183
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.0	57.4	28.7	0.0	0.0	136
N+1	12.8	50.0	36.2	1.1	1.1	94
N+2	17.4	49.3	31.9	1.4	2.5	69
N+3	31.9	34.0	34.0	0.0	2.5	47
N+4	29.3	41.5	26.8	2.4	4.9	41
N+5	36.1	30.6	33.3	0.0	4.9	36
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.8	5.6	93.5	0.0	0.0	124
N+1	0.0	3.8	82.7	13.5	13.5	52
N+2	0.0	6.3	84.4	9.4	21.6	32
N+3	0.0	16.7	77.8	5.6	25.9	18
N+4	0.0	30.8	61.5	7.7	31.6	13
N+5	18.2	18.2	63.6	0.0	31.6	11

TABLE 5.

REL OAK

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
			GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION			
N	32.0	32.0	35.2	0.8	0.8	125
N+1	23.2	29.0	46.4	1.4	2.2	69
N+2	45.9	18.9	35.1	0.0	2.2	37
N+3	69.6	8.7	21.7	0.0	2.2	23
N+4	81.3	0.0	18.8	0.0	2.2	16
N+5	84.6	0.0	15.4	0.0	2.2	13
			FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION			
N	16.7	1.9	81.5	0.0	0.0	54
N+1	37.5	0.0	12.5	50.0	50.0	8
N+2	75.0	0.0	25.0	0.0	50.0	4
N+3	100.0	0.0	0.0	0.0	50.0	3
N+4	0.0	0.0	0.0	0.0	50.0	0
N+5	0.0	0.0	0.0	0.0	50.0	0
			POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION			
N	0.0	0.0	100.0	0.0	0.0	25
N+1	0.0	50.0	0.0	50.0	50.0	2
N+2	0.0	0.0	0.0	0.0	50.0	0
N+3	0.0	0.0	0.0	0.0	50.0	0
N+4	0.0	0.0	0.0	0.0	50.0	0
N+5	0.0	0.0	0.0	0.0	50.0	0

TABLE 6.

RED OAK

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.0	33.6	20.7	1.7	1.7	116
N+1	63.9	12.5	15.3	8.3	9.9	72
N+2	71.7	7.5	20.8	0.0	9.9	53
N+3	65.0	10.0	25.0	0.0	9.9	20
N+4	58.3	16.7	16.7	8.3	17.4	12
N+5	62.5	25.0	12.5	0.0	17.4	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	25.7	54.3	0.0	0.0	35
N+1	33.3	20.8	29.2	16.7	16.7	24
N+2	41.7	25.0	25.0	8.3	23.6	12
N+3	60.0	0.0	40.0	0.0	23.6	5
N+4	33.3	33.3	33.3	0.0	23.6	3
N+5	0.0	100.0	0.0	0.0	23.6	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.9	2.9	91.4	2.9	2.9	35
N+1	4.8	4.8	85.7	4.8	7.5	21
N+2	0.0	0.0	40.0	60.0	63.0	5
N+3	0.0	0.0	0.0	0.0	63.0	0
N+4	0.0	0.0	0.0	0.0	63.0	0
N+5	0.0	0.0	0.0	0.0	63.0	0

TABLE 7.

RED OAK

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.6	3.7	0.5	0.2	0.2	1103
N+1	93.8	4.6	1.3	0.3	0.5	956
N+2	91.3	7.0	1.7	0.1	0.6	846
N+3	90.4	7.8	1.7	0.1	0.7	767
N+4	88.9	8.5	2.5	0.2	0.9	649
N+5	87.2	9.4	3.4	0.0	0.9	564
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	17.6	73.0	9.4	0.0	0.0	267
N+1	30.3	57.8	11.0	0.9	0.9	218
N+2	40.4	47.9	11.2	0.5	1.4	188
N+3	48.2	43.4	8.4	0.0	1.4	166
N+4	54.1	36.3	9.6	0.0	1.4	146
N+5	62.4	26.5	10.3	0.9	2.3	117
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.7	6.4	91.5	1.4	1.4	141
N+1	0.0	17.3	80.9	1.8	3.2	110
N+2	2.2	22.5	75.3	0.0	3.2	89
N+3	5.3	22.7	72.0	0.0	3.2	75
N+4	11.6	26.1	62.3	0.0	3.2	69
N+5	12.8	31.9	55.3	0.0	3.2	47

TABLE 8.

RED OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.9	16.3	2.9	0.0	0.0	209
N+1	77.2	18.1	4.7	0.0	0.0	149
N+2	79.7	10.2	10.2	0.0	0.0	128
N+3	79.6	11.8	8.6	0.0	0.0	93
N+4	80.0	11.8	8.2	0.0	0.0	85
N+5	81.5	11.1	7.4	0.0	0.0	81
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.0	48.0	36.0	0.0	0.0	25
N+1	40.0	26.7	33.3	0.0	0.0	15
N+2	27.3	27.3	45.5	0.0	0.0	11
N+3	28.6	14.3	57.1	0.0	0.0	7
N+4	33.3	16.7	50.0	0.0	0.0	6
N+5	50.0	0.0	50.0	0.0	0.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	18
N+1	0.0	0.0	83.3	16.7	16.7	12
N+2	0.0	0.0	100.0	0.0	16.7	5
N+3	0.0	33.3	66.7	0.0	16.7	3
N+4	0.0	33.3	66.7	0.0	16.7	3
N+5	0.0	100.0	0.0	0.0	16.7	1

TABLE 9.

RED OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOCC	FAIR	PCOR	CEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	62.5	28.1	9.4	0.0	0.0	32
N+1	82.6	8.7	8.7	0.0	0.0	23
N+2	81.3	0.0	18.8	0.0	0.0	16
N+3	71.4	0.0	28.6	0.0	0.0	7
N+4	83.3	0.0	16.7	0.0	0.0	6
N+5	100.0	0.0	0.0	0.0	0.0	5
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	20.0	0.0	80.0	0.0	0.0	5
N+1	50.0	0.0	50.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	0.0	0.0	0.0	C
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 10.

RED OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	90.4	9.6	0.0	0.0	0.0	94
N+1	85.7	13.0	1.3	0.0	0.0	77
N+2	85.5	10.1	4.3	0.0	0.0	69
N+3	81.1	15.1	3.8	0.0	0.0	53
N+4	73.7	23.7	2.6	0.0	0.0	38
N+5	70.6	23.5	5.9	0.0	0.0	34
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	22.2	55.6	22.2	0.0	0.0	18
N+1	27.3	36.4	36.4	0.0	0.0	11
N+2	30.0	30.0	40.0	0.0	0.0	10
N+3	42.9	14.3	42.9	0.0	0.0	7
N+4	40.0	20.0	40.0	0.0	0.0	5
N+5	50.0	0.0	50.0	0.0	0.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	11
N+1	0.0	0.0	88.9	11.1	11.1	9
N+2	0.0	20.0	80.0	0.0	11.1	5
N+3	0.0	66.7	33.3	0.0	11.1	3
N+4	0.0	50.0	50.0	0.0	11.1	2
N+5	0.0	100.0	0.0	0.0	11.1	1

TABLE 11.

RED OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	98.9	1.1	0.0	0.0	0.0	181
N+1	96.6	2.7	0.7	0.0	0.0	149
N+2	96.6	2.5	0.8	0.0	0.0	119
N+3	96.2	2.8	0.9	0.0	0.0	106
N+4	95.6	2.2	2.2	0.0	0.0	91
N+5	95.9	1.4	2.7	0.0	0.0	74
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	25.8	71.0	3.2	0.0	0.0	31
N+1	48.0	48.0	4.0	0.0	0.0	25
N+2	50.0	50.0	0.0	0.0	0.0	22
N+3	66.7	33.3	0.0	0.0	0.0	21
N+4	64.7	35.3	0.0	0.0	0.0	17
N+5	66.7	33.3	0.0	0.0	0.0	12
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	5.9	94.1	0.0	0.0	17
N+1	0.0	16.7	83.3	0.0	0.0	12
N+2	0.0	33.3	66.7	0.0	0.0	9
N+3	0.0	28.6	71.4	0.0	0.0	7
N+4	25.0	25.0	50.0	0.0	0.0	4
N+5	0.0	66.7	33.3	0.0	0.0	3

TABLE 12.

RED OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.1	27.5	7.4	0.0	0.0	619
N+1	73.7	17.1	8.9	0.3	0.3	392
N+2	74.5	16.7	8.8	0.0	0.3	330
N+3	73.0	19.1	7.9	0.0	0.3	215
N+4	72.9	18.8	8.3	0.0	0.3	192
N+5	75.7	15.1	9.2	0.0	0.3	152
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	24.4	40.6	34.4	0.6	0.6	160
N+1	31.0	26.0	37.0	6.0	6.6	100
N+2	31.7	35.0	31.7	1.7	8.1	60
N+3	25.9	29.6	44.4	0.0	8.1	27
N+4	22.7	40.9	36.4	0.0	8.1	22
N+5	28.6	42.9	28.6	0.0	8.1	21
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	8.8	90.1	1.1	1.1	91
N+1	0.0	8.0	68.0	24.0	24.8	25
N+2	0.0	0.0	90.0	10.0	32.4	10
N+3	0.0	0.0	100.0	0.0	32.4	5
N+4	0.0	33.3	66.7	0.0	32.4	3
N+5	33.3	0.0	66.7	0.0	32.4	3

TABLE 13.

RED OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	49.3	27.4	23.3	0.0	0.0	146
N+1	71.8	14.1	9.4	4.7	4.7	85
N+2	77.9	5.9	14.7	1.5	6.1	68
N+3	69.2	15.4	15.4	0.0	6.1	26
N+4	71.4	19.0	9.5	0.0	6.1	21
N+5	75.0	12.5	12.5	0.0	6.1	16
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	12.5	12.5	75.0	0.0	0.0	16
N+1	25.0	12.5	50.0	12.5	12.5	8
N+2	25.0	0.0	75.0	0.0	12.5	4
N+3	100.0	0.0	0.0	0.0	12.5	1
N+4	100.0	0.0	0.0	0.0	12.5	1
N+5	0.0	0.0	0.0	0.0	12.5	C
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	5.6	94.4	0.0	0.0	18
N+1	0.0	0.0	78.6	21.4	21.4	14
N+2	0.0	0.0	100.0	0.0	21.4	2
N+3	0.0	0.0	100.0	0.0	21.4	1
N+4	0.0	0.0	100.0	0.0	21.4	1
N+5	0.0	0.0	100.0	0.0	21.4	1

TABLE 14.

RED OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.7	12.3	2.0	0.0	0.0	203
N+1	75.7	16.4	7.9	0.0	0.0	177
N+2	70.6	20.0	9.4	0.0	0.0	160
N+3	71.7	18.3	10.0	0.0	0.0	120
N+4	69.7	19.2	11.1	0.0	0.0	99
N+5	68.4	20.3	11.4	0.0	0.0	79
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.0	57.9	28.1	0.0	0.0	57
N+1	12.5	52.5	35.0	0.0	0.0	40
N+2	7.1	60.7	32.1	0.0	0.0	28
N+3	16.7	44.4	38.9	0.0	0.0	18
N+4	18.8	50.0	31.3	0.0	0.0	16
N+5	26.7	46.7	26.7	0.0	0.0	15
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	13.9	86.1	0.0	0.0	36
N+1	0.0	14.3	85.7	0.0	0.0	7
N+2	0.0	0.0	100.0	0.0	0.0	5
N+3	0.0	0.0	100.0	0.0	0.0	3
N+4	0.0	50.0	50.0	0.0	0.0	2
N+5	50.0	0.0	50.0	0.0	0.0	2

TABLE 15.

RED OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	31.0	35.7	33.3	0.0	0.0	42
N+1	19.0	38.1	42.9	0.0	0.0	21
N+2	27.3	36.4	36.4	0.0	0.0	11
N+3	60.0	0.0	40.0	0.0	0.0	5
N+4	50.0	0.0	50.0	0.0	0.0	2
N+5	50.0	0.0	50.0	0.0	0.0	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.8	0.0	81.3	0.0	0.0	16
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	7
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 16.

RED OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	19.6	46.4	33.9	0.0	0.0	56
N+1	40.9	22.7	31.8	4.5	4.5	22
N+2	50.0	12.5	37.5	0.0	4.5	16
N+3	55.6	22.2	22.2	0.0	4.5	9
N+4	0.0	50.0	50.0	0.0	4.5	2
N+5	0.0	100.0	0.0	0.0	4.5	1
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	30.0	10.0	60.0	0.0	0.0	1C
N+1	75.0	0.0	25.0	0.0	0.0	4
N+2	100.0	0.0	0.0	0.0	0.0	2
N+3	100.0	0.0	0.0	0.0	0.0	2
N+4	100.0	0.0	0.0	0.0	0.0	1
N+5	0.0	0.0	0.0	0.0	0.0	C
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	10.0	90.0	0.0	0.0	1C
N+1	0.0	0.0	100.0	0.0	0.0	8
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 17.

RED OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.2	4.0	0.8	0.0	0.0	495
N+1	94.4	4.2	1.2	0.2	0.2	427
N+2	91.0	7.7	1.3	0.0	0.2	390
N+3	90.3	8.5	1.1	0.0	0.2	352
N+4	89.1	9.9	1.1	0.0	0.2	284
N+5	86.7	12.1	1.2	0.0	0.2	256
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	15.9	74.8	9.3	0.0	0.0	107
N+1	27.5	64.8	7.7	0.0	0.0	91
N+2	47.4	43.6	9.0	0.0	0.0	78
N+3	55.7	41.4	2.9	0.0	0.0	70
N+4	61.3	33.9	4.8	0.0	0.0	62
N+5	74.1	18.5	5.6	1.9	1.9	54
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	2.4	7.1	90.5	0.0	0.0	42
N+1	0.0	20.0	80.0	0.0	0.0	35
N+2	3.4	17.2	79.3	0.0	0.0	29
N+3	8.7	21.7	69.6	0.0	0.0	23
N+4	9.1	27.3	63.6	0.0	0.0	22
N+5	13.3	13.3	73.3	0.0	0.0	15

TABLE 18.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	68.9	24.6	6.1	0.4	0.4	228
N+1	63.8	20.7	7.4	8.0	8.4	188
N+2	74.3	16.0	6.9	2.8	10.9	144
N+3	62.8	24.4	8.1	4.7	15.1	86
N+4	66.7	21.8	10.3	1.3	16.2	78
N+5	63.8	26.1	10.1	0.0	16.2	69
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.9	55.4	24.3	1.4	1.4	74
N+1	7.1	41.1	28.6	23.2	24.3	56
N+2	12.1	30.3	48.5	9.1	31.1	33
N+3	45.5	45.5	9.1	0.0	31.1	11
N+4	55.6	44.4	0.0	0.0	31.1	9
N+5	62.5	25.0	12.5	0.0	31.1	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.1	5.1	89.7	0.0	0.0	39
N+1	3.0	3.0	69.7	24.2	24.2	33
N+2	5.6	0.0	83.3	11.1	32.7	18
N+3	0.0	16.7	66.7	16.7	43.9	6
N+4	0.0	50.0	25.0	25.0	57.9	4
N+5	33.3	33.3	33.3	0.0	57.9	3

TABLE 19.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	19.4	13.9	0.0	0.0	36
N+1	54.5	9.1	4.5	31.8	31.8	22
N+2	76.9	0.0	23.1	0.0	31.8	13
N+3	100.0	0.0	0.0	0.0	31.8	4
N+4	100.0	0.0	0.0	0.0	31.8	3
N+5	66.7	33.3	0.0	0.0	31.8	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	28.6	21.4	50.0	0.0	0.0	14
N+1	18.2	18.2	9.1	54.5	54.5	11
N+2	100.0	0.0	0.0	0.0	54.5	1
N+3	0.0	0.0	0.0	0.0	54.5	0
N+4	0.0	0.0	0.0	0.0	54.5	0
N+5	0.0	0.0	0.0	0.0	54.5	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	0.0	80.0	0.0	0.0	5
N+1	20.0	0.0	80.0	0.0	0.0	5
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 20.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	77.7	19.8	2.5	0.0	0.0	121
N+1	68.0	24.0	8.0	0.0	0.0	100
N+2	68.9	24.4	5.6	1.1	1.1	90
N+3	65.5	22.4	6.9	5.2	6.2	58
N+4	66.0	26.4	5.7	1.9	8.0	53
N+5	61.7	31.9	6.4	0.0	8.0	47
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.9	67.9	14.3	0.0	0.0	28
N+1	15.8	57.9	21.1	5.3	5.3	19
N+2	30.8	69.2	0.0	0.0	5.3	13
N+3	60.0	40.0	0.0	0.0	5.3	10
N+4	55.6	44.4	0.0	0.0	5.3	9
N+5	62.5	25.0	12.5	0.0	5.3	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.9	2.9	94.3	0.0	0.0	35
N+1	0.0	0.0	85.7	14.3	14.3	14
N+2	0.0	0.0	90.0	10.0	22.9	10
N+3	0.0	25.0	75.0	0.0	22.9	4
N+4	0.0	50.0	25.0	25.0	42.1	4
N+5	33.3	33.3	33.3	0.0	42.1	3

TABLE 21.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	36.4	22.7	36.4	4.5	4.5	22
N+1	42.9	28.6	28.6	0.0	4.5	7
N+2	100.0	0.0	0.0	0.0	4.5	4
N+3	75.0	25.0	0.0	0.0	4.5	4
N+4	100.0	0.0	0.0	0.0	4.5	3
N+5	100.0	0.0	0.0	0.0	4.5	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	11.1	0.0	88.9	0.0	0.0	9
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	6
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 22.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.8	11.5	3.8	3.8	3.8	26
N+1	85.0	0.0	0.0	15.0	18.3	20
N+2	100.0	0.0	0.0	0.0	18.3	15
N+3	100.0	0.0	0.0	0.0	18.3	1
N+4	100.0	0.0	0.0	0.0	18.3	1
N+5	0.0	100.0	0.0	0.0	18.3	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	41.7	33.3	0.0	0.0	12
N+1	33.3	33.3	11.1	22.2	22.2	9
N+2	50.0	50.0	0.0	0.0	22.2	4
N+3	0.0	0.0	0.0	0.0	22.2	0
N+4	0.0	0.0	0.0	0.0	22.2	0
N+5	0.0	0.0	0.0	0.0	22.2	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.0	0.0	90.0	0.0	0.0	10
N+1	16.7	16.7	66.7	0.0	0.0	6
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 23.

RED OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.8	5.1	0.5	0.5	0.5	195
N+1	91.3	7.0	1.2	0.6	1.1	172
N+2	88.4	9.6	1.4	0.7	1.8	146
N+3	88.5	8.5	2.3	0.8	2.5	130
N+4	87.8	7.8	3.5	0.9	3.4	115
N+5	86.1	7.9	5.9	0.0	3.4	101
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	14.8	75.9	9.3	0.0	0.0	54
N+1	42.9	40.5	16.7	0.0	0.0	42
N+2	43.8	40.6	15.6	0.0	0.0	32
N+3	52.2	39.1	8.7	0.0	0.0	23
N+4	77.3	13.6	9.1	0.0	0.0	22
N+5	84.6	7.7	7.7	0.0	0.0	13
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	9.1	86.4	4.5	4.5	22
N+1	0.0	33.3	66.7	0.0	4.5	12
N+2	0.0	37.5	62.5	0.0	4.5	8
N+3	0.0	50.0	50.0	0.0	4.5	6
N+4	50.0	50.0	0.0	0.0	4.5	4
N+5	0.0	100.0	0.0	0.0	4.5	1

TABLE 24.

RED OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	55.4	29.8	13.2	1.7	1.7	121
N+1	53.8	18.3	15.1	12.9	14.3	93
N+2	70.4	14.8	9.3	5.6	19.1	54
N+3	58.5	24.4	17.1	0.0	19.1	41
N+4	65.8	21.1	10.5	2.6	21.2	38
N+5	76.7	10.0	13.3	0.0	21.2	30
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.2	58.5	26.4	1.9	1.9	53
N+1	11.6	20.9	37.2	30.2	31.5	43
N+2	10.5	21.1	47.4	21.1	46.0	19
N+3	16.7	66.7	16.7	0.0	46.0	6
N+4	20.0	60.0	20.0	0.0	46.0	5
N+5	40.0	40.0	20.0	0.0	46.0	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	9.4	90.6	0.0	0.0	32
N+1	0.0	8.0	64.0	28.0	28.0	25
N+2	0.0	0.0	90.9	9.1	34.5	11
N+3	0.0	0.0	75.0	25.0	50.9	4
N+4	0.0	0.0	100.0	0.0	50.9	2
N+5	0.0	0.0	100.0	0.0	50.9	2

TABLE 25.

RED OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	26.9	50.0	15.4	7.7	7.7	26
N+1	42.9	0.0	21.4	35.7	40.7	14
N+2	83.3	16.7	0.0	0.0	40.7	6
N+3	80.0	0.0	20.0	0.0	40.7	5
N+4	80.0	20.0	0.0	0.0	40.7	5
N+5	80.0	0.0	20.0	0.0	40.7	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	75.0	0.0	0.0	8
N+1	20.0	0.0	0.0	80.0	80.0	5
N+2	100.0	0.0	0.0	0.0	80.0	1
N+3	100.0	0.0	0.0	0.0	80.0	1
N+4	0.0	100.0	0.0	0.0	80.0	1
N+5	0.0	100.0	0.0	0.0	80.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 26.

RED OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	89.7	10.3	0.0	0.0	0.0	29
N+1	65.2	8.7	13.0	13.0	13.0	23
N+2	61.1	16.7	16.7	5.6	17.9	18
N+3	66.7	16.7	16.7	0.0	17.9	12
N+4	70.0	10.0	20.0	0.0	17.9	10
N+5	87.5	0.0	12.5	0.0	17.9	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	50.0	41.7	0.0	0.0	12
N+1	0.0	62.5	37.5	0.0	0.0	8
N+2	0.0	50.0	50.0	0.0	0.0	6
N+3	0.0	75.0	25.0	0.0	0.0	4
N+4	0.0	75.0	25.0	0.0	0.0	4
N+5	25.0	50.0	25.0	0.0	0.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	19
N+1	0.0	0.0	72.7	27.3	27.3	11
N+2	0.0	0.0	100.0	0.0	27.3	5
N+3	0.0	0.0	75.0	25.0	45.5	4
N+4	0.0	0.0	100.0	0.0	45.5	2
N+5	0.0	0.0	100.0	0.0	45.5	2

TABLE 27.

RED OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	52.0	28.0	0.0	0.0	25
N+1	0.0	29.4	64.7	5.9	5.9	17
N+2	0.0	20.0	80.0	0.0	5.9	5
N+3	0.0	50.0	50.0	0.0	5.9	2
N+4	0.0	0.0	0.0	0.0	5.9	0
N+5	0.0	0.0	0.0	0.0	5.9	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	9.1	72.7	0.0	0.0	11
N+1	0.0	0.0	0.0	100.0	100.0	2
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	100.0	0.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 28.

RED OAK * INTERMECIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCC	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	98.3	0.8	0.8	0.0	0.0	118
N+1	99.1	0.0	0.9	0.0	0.0	107
N+2	97.1	1.9	1.0	0.0	0.0	103
N+3	96.9	2.0	1.0	0.0	0.0	98
N+4	98.8	1.2	0.0	0.0	0.0	85
N+5	97.3	1.4	1.4	0.0	0.0	74
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	37.0	59.3	3.7	0.0	0.0	27
N+1	44.4	50.0	5.6	0.0	0.0	18
N+2	52.9	41.2	5.9	0.0	0.0	17
N+3	66.7	26.7	6.7	0.0	0.0	15
N+4	69.2	23.1	7.7	0.0	0.0	13
N+5	66.7	33.3	0.0	0.0	0.0	12
POCR CCNDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	16.7	75.0	8.3	8.3	12
N+1	0.0	28.6	71.4	0.0	8.3	7
N+2	0.0	66.7	33.3	0.0	8.3	6
N+3	0.0	50.0	50.0	0.0	8.3	4
N+4	25.0	25.0	50.0	0.0	8.3	4
N+5	66.7	33.3	0.0	0.0	8.3	3

TABLE 29.

RED OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.6	33.6	9.8	0.0	0.0	122
N+1	55.6	17.8	15.6	11.1	11.1	90
N+2	64.4	11.9	15.3	8.5	18.6	59
N+3	60.0	27.5	7.5	5.0	22.7	40
N+4	69.4	19.4	11.1	0.0	22.7	36
N+5	66.7	15.2	15.2	3.0	25.1	33
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.3	43.5	40.0	1.2	1.2	85
N+1	15.5	22.5	40.8	21.1	22.1	71
N+2	13.5	24.3	54.1	8.1	28.4	37
N+3	28.6	7.1	57.1	7.1	33.5	14
N+4	18.2	9.1	45.5	27.3	51.6	11
N+5	16.7	0.0	83.3	0.0	51.6	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.7	8.6	89.7	0.0	0.0	58
N+1	2.3	2.3	58.1	37.2	37.2	43
N+2	0.0	5.9	64.7	29.4	55.7	17
N+3	0.0	0.0	71.4	28.6	68.3	7
N+4	0.0	0.0	100.0	0.0	68.3	4
N+5	0.0	0.0	100.0	0.0	68.3	3

TABLE 30.

RED OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	46.4	28.6	21.4	3.6	3.6	28
N+1	15.4	23.1	30.8	30.8	33.2	13
N+2	33.3	0.0	55.6	11.1	40.7	9
N+3	50.0	0.0	25.0	25.0	55.5	4
N+4	50.0	0.0	0.0	50.0	77.7	2
N+5	100.0	0.0	0.0	0.0	77.7	1
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	66.7	8.3	8.3	12
N+1	0.0	10.0	40.0	50.0	54.2	10
N+2	0.0	0.0	50.0	50.0	77.1	2
N+3	0.0	0.0	0.0	0.0	77.1	C
N+4	0.0	0.0	0.0	0.0	77.1	C
N+5	0.0	0.0	0.0	0.0	77.1	C
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	7
N+1	0.0	0.0	50.0	50.0	50.0	4
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 31.

RED OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	63.6	27.3	9.1	0.0	0.0	33
N+1	69.2	15.4	15.4	0.0	0.0	26
N+2	69.6	17.4	13.0	0.0	0.0	23
N+3	72.2	11.1	11.1	5.6	5.6	18
N+4	71.4	14.3	14.3	0.0	5.6	14
N+5	63.6	18.2	18.2	0.0	5.6	11
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.9	47.1	47.1	0.0	0.0	17
N+1	8.3	25.0	66.7	0.0	0.0	12
N+2	25.0	12.5	50.0	12.5	12.5	8
N+3	40.0	0.0	60.0	0.0	12.5	5
N+4	20.0	20.0	40.0	20.0	30.0	5
N+5	25.0	0.0	75.0	0.0	30.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.5	95.5	0.0	0.0	22
N+1	0.0	10.0	80.0	10.0	10.0	10
N+2	0.0	16.7	66.7	16.7	25.0	6
N+3	0.0	0.0	100.0	0.0	25.0	4
N+4	0.0	0.0	100.0	0.0	25.0	3
N+5	0.0	0.0	100.0	0.0	25.0	3

TABLE 32.

RED OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.9	6.1	0.0	1.0	1.0	99
N+1	86.0	9.3	3.5	1.2	2.2	86
N+2	84.0	9.3	6.7	0.0	2.2	75
N+3	79.4	14.7	5.9	0.0	2.2	68
N+4	72.1	16.4	11.5	0.0	2.2	61
N+5	70.8	14.6	14.6	0.0	2.2	48
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	10.5	71.1	18.4	0.0	0.0	38
N+1	9.4	62.5	25.0	3.1	3.1	32
N+2	16.7	53.3	26.7	3.3	6.4	30
N+3	17.9	50.0	32.1	0.0	6.4	28
N+4	17.4	47.8	34.8	0.0	6.4	23
N+5	30.0	30.0	40.0	0.0	6.4	20
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	2.2	97.8	0.0	0.0	46
N+1	0.0	7.1	88.1	4.8	4.8	42
N+2	2.9	14.3	82.9	0.0	4.8	35
N+3	6.1	15.2	78.8	0.0	4.8	33
N+4	6.1	21.2	72.7	0.0	4.8	33
N+5	8.3	37.5	54.2	0.0	4.8	24

TABLE 33.

BLACK OAK

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.0	22.0	3.7	0.3	0.3	918
N+1	67.0	17.4	9.8	5.9	6.2	769
N+2	69.2	15.6	10.9	4.3	10.2	603
N+3	62.4	20.2	15.3	2.0	12.0	450
N+4	59.1	23.3	14.8	2.8	14.5	318
N+5	60.1	20.5	16.9	2.5	16.6	278
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.2	53.4	28.2	1.3	1.3	238
N+1	31.9	24.2	30.8	13.2	14.3	182
N+2	21.9	22.9	39.6	15.6	27.7	96
N+3	24.5	30.6	40.8	4.1	30.6	49
N+4	8.8	32.4	55.9	2.9	32.7	34
N+5	10.0	26.7	56.7	6.7	37.2	30
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.8	8.5	86.8	1.9	1.9	106
N+1	3.3	4.9	55.7	36.1	37.3	61
N+2	0.0	6.7	83.3	10.0	43.5	30
N+3	0.0	3.8	88.5	7.7	47.9	26
N+4	0.0	5.0	90.0	5.0	50.5	20
N+5	0.0	6.7	86.7	6.7	53.8	15

TABLE 34.

BLACK OAK

DEFOLIATION HISTORY--HH

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	67.0	21.1	8.3	3.7	3.7	1C9
N+1	68.2	14.8	8.0	9.1	12.4	88
N+2	72.2	12.5	12.5	2.8	14.9	72
N+3	70.8	10.4	14.6	4.2	18.4	48
N+4	64.5	12.9	9.7	12.9	28.9	31
N+5	75.0	8.3	4.2	12.5	37.8	24
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	22.6	16.1	51.6	9.7	9.7	31
N+1	16.7	27.8	16.7	38.9	44.8	18
N+2	37.5	37.5	25.0	0.0	44.8	8
N+3	50.0	0.0	50.0	0.0	44.8	2
N+4	0.0	0.0	100.0	0.0	44.8	1
N+5	0.0	0.0	100.0	0.0	44.8	1
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	12.5	6.3	68.8	12.5	12.5	16
N+1	36.4	0.0	27.3	36.4	44.3	11
N+2	25.0	0.0	75.0	0.0	44.3	4
N+3	0.0	0.0	100.0	0.0	44.3	1
N+4	0.0	0.0	0.0	0.0	44.3	C
N+5	0.0	0.0	0.0	0.0	44.3	C

TABLE 35.

BLACK OAK

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	72.7	24.0	3.4	0.0	0.0	388
N+1	59.8	24.6	13.9	1.7	1.7	346
N+2	57.7	22.2	15.5	4.6	6.2	284
N+3	46.7	26.9	23.9	2.5	8.6	197
N+4	35.1	37.3	25.4	2.2	10.7	134
N+5	33.1	36.2	30.7	0.0	10.7	127
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.2	55.2	40.6	0.0	0.0	96
N+1	12.7	31.6	48.1	7.6	7.6	79
N+2	20.3	25.0	46.9	7.8	14.8	64
N+3	11.1	36.1	50.0	2.8	17.2	36
N+4	0.0	34.8	60.9	4.3	20.8	23
N+5	0.0	35.0	65.0	0.0	20.8	20
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.4	2.8	94.4	1.4	1.4	72
N+1	0.0	7.5	72.5	20.0	21.1	40
N+2	0.0	10.7	78.6	10.7	29.6	28
N+3	0.0	8.7	91.3	0.0	29.6	23
N+4	0.0	5.6	88.9	5.6	33.5	18
N+5	0.0	7.7	84.6	7.7	38.6	13

TABLE 36.

BLACK OAK

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	73.2	19.5	6.1	1.2	1.2	82
N+1	63.5	23.1	7.7	5.8	6.9	52
N+2	66.7	18.8	10.4	4.2	10.8	48
N+3	82.5	5.0	10.0	2.5	13.0	40
N+4	83.3	0.0	11.1	5.6	17.9	18
N+5	88.2	0.0	11.8	0.0	17.9	17
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.8	81.0	14.3	0.0	0.0	42
N+1	43.2	45.9	10.8	0.0	0.0	37
N+2	73.0	16.2	5.4	5.4	5.4	37
N+3	85.3	11.8	2.9	0.0	5.4	34
N+4	0.0	0.0	0.0	0.0	5.4	0
N+5	0.0	0.0	0.0	0.0	5.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	50.0	50.0	0.0	0.0	2
N+1	100.0	0.0	0.0	0.0	0.0	1
N+2	100.0	0.0	0.0	0.0	0.0	1
N+3	100.0	0.0	0.0	0.0	0.0	1
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 37.

BLACK OAK

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	35.6	46.7	11.1	6.7	6.7	45
N+1	44.7	31.6	13.2	10.5	16.5	38
N+2	56.7	20.0	20.0	3.3	19.3	30
N+3	66.7	11.1	11.1	11.1	28.2	9
N+4	33.3	33.3	33.3	0.0	28.2	3
N+5	33.3	33.3	0.0	33.3	52.2	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	14.3	57.1	14.3	14.3	21
N+1	22.2	22.2	22.2	33.3	42.9	9
N+2	40.0	40.0	20.0	0.0	42.9	5
N+3	0.0	0.0	100.0	0.0	42.9	1
N+4	0.0	0.0	100.0	0.0	42.9	1
N+5	0.0	0.0	100.0	0.0	42.9	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	10.0	70.0	20.0	20.0	10
N+1	25.0	0.0	75.0	0.0	20.0	4
N+2	0.0	0.0	100.0	0.0	20.0	1
N+3	0.0	0.0	0.0	0.0	20.0	0
N+4	0.0	0.0	0.0	0.0	20.0	0
N+5	0.0	0.0	0.0	0.0	20.0	0

TABLE 38.

BLACK OAK

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.7	3.9	1.1	0.3	0.3	359
N+1	91.6	6.3	1.4	0.7	1.0	285
N+2	87.3	8.8	3.4	0.5	1.5	205
N+3	83.4	12.3	4.3	0.0	1.5	163
N+4	83.1	12.5	4.4	0.0	1.5	136
N+5	78.6	15.5	6.0	0.0	1.5	84
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	22.7	68.6	8.1	0.6	0.6	172
N+1	41.4	45.1	12.3	1.2	1.8	162
N+2	47.6	38.1	14.3	0.0	1.8	126
N+3	49.1	36.8	14.0	0.0	1.8	114
N+4	60.2	27.6	12.2	0.0	1.8	98
N+5	47.7	38.5	12.3	1.5	3.3	65
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	11.1	83.7	5.2	5.2	153
N+1	4.7	17.1	77.5	0.8	6.0	129
N+2	6.5	21.3	72.2	0.0	6.0	108
N+3	9.0	32.0	59.0	0.0	6.0	100
N+4	18.3	28.0	53.8	0.0	6.0	93
N+5	21.7	15.2	63.0	0.0	6.0	46

TABLE 39.

BLACK OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	69.7	28.1	2.2	0.0	0.0	178
N+1	65.4	21.8	8.3	4.5	4.5	156
N+2	76.3	11.9	7.4	4.4	8.7	135
N+3	73.8	16.5	8.7	1.0	9.6	103
N+4	65.2	22.7	12.1	0.0	9.6	66
N+5	66.1	21.0	12.9	0.0	9.6	62
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	7.5	67.5	22.5	2.5	2.5	40
N+1	61.8	20.6	14.7	2.9	5.4	34
N+2	0.0	57.1	14.3	28.6	32.4	7
N+3	33.3	0.0	66.7	0.0	32.4	3
N+4	0.0	0.0	100.0	0.0	32.4	2
N+5	0.0	0.0	100.0	0.0	32.4	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.1	27.3	54.5	9.1	9.1	11
N+1	20.0	0.0	20.0	60.0	63.6	5
N+2	0.0	0.0	100.0	0.0	63.6	1
N+3	0.0	0.0	100.0	0.0	63.6	1
N+4	0.0	0.0	0.0	0.0	63.6	0
N+5	0.0	0.0	0.0	0.0	63.6	0

TABLE 40.

BLACK OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	73.6	25.3	1.1	0.0	0.0	91
N+1	62.4	22.4	12.9	2.4	2.4	85
N+2	61.4	20.0	12.9	5.7	7.9	70
N+3	57.7	25.0	15.4	1.9	9.7	52
N+4	37.1	42.9	20.0	0.0	9.7	35
N+5	41.2	35.3	23.5	0.0	9.7	34
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	66.7	33.3	0.0	0.0	6
N+1	50.0	16.7	33.3	0.0	0.0	6
N+2	60.0	20.0	20.0	0.0	0.0	5
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	80.0	0.0	0.0	5
N+1	0.0	0.0	33.3	66.7	66.7	3
N+2	0.0	100.0	0.0	0.0	66.7	1
N+3	0.0	100.0	0.0	0.0	66.7	1
N+4	0.0	0.0	0.0	0.0	66.7	0
N+5	0.0	0.0	0.0	0.0	66.7	0

TABLE 41.

BLACK OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCCD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	90.9	9.1	0.0	0.0	0.0	11
N+1	100.0	0.0	0.0	0.0	0.0	4
N+2	75.0	0.0	25.0	0.0	0.0	4
N+3	100.0	0.0	0.0	0.0	0.0	2
N+4	100.0	0.0	0.0	0.0	0.0	2
N+5	100.0	0.0	0.0	0.0	0.0	2
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	4.2	83.3	12.5	0.0	0.0	24
N+1	45.5	45.5	9.1	0.0	0.0	22
N+2	81.8	9.1	4.5	4.5	4.5	22
N+3	95.2	0.0	4.8	0.0	4.5	21
N+4	0.0	0.0	0.0	0.0	4.5	0
N+5	0.0	0.0	0.0	0.0	4.5	0
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	1
N+1	100.0	0.0	0.0	0.0	0.0	1
N+2	100.0	0.0	0.0	0.0	0.0	1
N+3	100.0	0.0	0.0	0.0	0.0	1
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 42.

BLACK OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	80
N+1	97.0	3.0	0.0	0.0	0.0	67
N+2	91.7	8.3	0.0	0.0	0.0	48
N+3	90.2	4.9	4.9	0.0	0.0	41
N+4	88.9	5.6	5.6	0.0	0.0	36
N+5	73.7	15.8	10.5	0.0	0.0	19
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	16.1	71.0	12.9	0.0	0.0	31
N+1	38.7	45.2	16.1	0.0	0.0	31
N+2	44.4	37.0	18.5	0.0	0.0	27
N+3	57.7	23.1	19.2	0.0	0.0	26
N+4	66.7	20.8	12.5	0.0	0.0	24
N+5	64.7	23.5	11.8	0.0	0.0	17
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	15.0	85.0	0.0	0.0	20
N+1	11.8	23.5	64.7	0.0	0.0	17
N+2	8.3	41.7	50.0	0.0	0.0	12
N+3	25.0	33.3	41.7	0.0	0.0	12
N+4	33.3	33.3	33.3	0.0	0.0	12
N+5	40.0	40.0	20.0	0.0	0.0	5

TABLE 43.

BLACK OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	81.2	14.5	3.7	0.6	0.6	324
N+1	74.5	14.8	8.1	2.6	3.2	271
N+2	73.9	12.4	10.6	3.2	6.3	218
N+3	65.6	16.6	17.8	0.0	6.3	163
N+4	64.8	19.7	13.9	1.6	7.8	122
N+5	61.9	19.0	18.1	1.0	8.7	105
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.3	57.4	32.4	0.0	0.0	68
N+1	10.9	36.4	36.4	16.4	16.4	55
N+2	10.8	27.0	54.1	8.1	23.1	37
N+3	10.5	36.8	52.6	0.0	23.1	19
N+4	0.0	38.5	61.5	0.0	23.1	13
N+5	0.0	36.4	63.6	0.0	23.1	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	2.8	97.2	0.0	0.0	36
N+1	0.0	4.5	72.7	22.7	22.7	22
N+2	0.0	0.0	100.0	0.0	22.7	14
N+3	0.0	0.0	100.0	0.0	22.7	14
N+4	0.0	0.0	91.7	8.3	29.2	12
N+5	0.0	0.0	100.0	0.0	29.2	9

TABLE 44.

BLACK OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	71.4	19.0	7.1	2.4	2.4	42
N+1	70.6	23.5	0.0	5.9	8.1	34
N+2	76.7	10.0	6.7	6.7	14.2	30
N+3	84.2	0.0	15.8	0.0	14.2	19
N+4	76.9	0.0	7.7	15.4	27.4	13
N+5	88.9	0.0	0.0	11.1	35.5	9
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	14.3	57.1	14.3	14.3	7
N+1	0.0	0.0	50.0	50.0	57.1	2
N+2	0.0	0.0	100.0	0.0	57.1	1
N+3	0.0	0.0	0.0	0.0	57.1	0
N+4	0.0	0.0	0.0	0.0	57.1	0
N+5	0.0	0.0	0.0	0.0	57.1	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	5
N+1	0.0	0.0	33.3	66.7	66.7	3
N+2	0.0	0.0	0.0	0.0	66.7	0
N+3	0.0	0.0	0.0	0.0	66.7	0
N+4	0.0	0.0	0.0	0.0	66.7	0
N+5	0.0	0.0	0.0	0.0	66.7	0

TABLE 45.

BLACK OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.9	15.7	4.4	0.0	0.0	159
N+1	66.9	19.7	12.7	0.7	0.7	142
N+2	63.2	17.5	14.9	4.4	5.1	114
N+3	45.9	25.7	28.4	0.0	5.1	74
N+4	36.7	36.7	26.5	0.0	5.1	49
N+5	29.2	35.4	35.4	0.0	5.1	48
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	60.5	39.5	0.0	0.0	38
N+1	9.1	42.4	42.4	6.1	6.1	33
N+2	10.7	32.1	57.1	0.0	6.1	28
N+3	5.6	38.9	55.6	0.0	6.1	18
N+4	0.0	38.5	61.5	0.0	6.1	13
N+5	0.0	36.4	63.6	0.0	6.1	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	96.8	3.2	3.2	31
N+1	0.0	5.0	85.0	10.0	12.9	20
N+2	0.0	0.0	93.8	6.3	18.3	16
N+3	0.0	0.0	100.0	0.0	18.3	15
N+4	0.0	0.0	91.7	8.3	25.2	12
N+5	0.0	0.0	100.0	0.0	25.2	9

TABLE 46.

BLACK OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.3	13.8	6.9	0.0	0.0	29
N+1	73.9	17.4	8.7	0.0	0.0	23
N+2	77.3	13.6	4.5	4.5	4.5	22
N+3	95.0	0.0	5.0	0.0	4.5	20
N+4	90.0	0.0	10.0	0.0	4.5	10
N+5	90.0	0.0	10.0	0.0	4.5	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	50.0	33.3	0.0	0.0	6
N+1	75.0	25.0	0.0	0.0	0.0	4
N+2	75.0	25.0	0.0	0.0	0.0	4
N+3	66.7	33.3	0.0	0.0	0.0	3
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 47.

BLACK OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	91.8	5.4	2.0	0.7	0.7	147
N+1	90.4	6.1	1.7	1.7	2.4	115
N+2	83.1	9.1	6.5	1.3	3.7	77
N+3	76.3	15.3	8.5	0.0	3.7	59
N+4	77.1	14.6	8.3	0.0	3.7	48
N+5	71.4	21.4	7.1	0.0	3.7	28
FAIR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	27.7	67.7	4.6	0.0	0.0	65
N+1	43.5	46.8	9.7	0.0	0.0	62
N+2	51.1	35.6	13.3	0.0	0.0	45
N+3	47.4	36.8	15.8	0.0	0.0	38
N+4	61.3	22.6	16.1	0.0	0.0	31
N+5	31.6	47.4	15.8	5.3	5.3	19
POCR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	5.8	94.2	0.0	0.0	69
N+1	3.0	16.7	80.3	0.0	0.0	66
N+2	5.1	18.6	76.3	0.0	0.0	59
N+3	7.3	29.1	63.6	0.0	0.0	55
N+4	17.3	26.9	55.8	0.0	0.0	52
N+5	22.2	11.1	66.7	0.0	0.0	27

TABLE 48.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	71.7	24.3	3.5	0.4	0.4	226
N+1	64.2	17.9	11.6	6.3	6.7	190
N+2	62.9	20.3	13.3	3.5	10.0	143
N+3	55.9	23.4	16.2	4.5	14.0	111
N+4	51.3	30.8	12.8	5.1	18.5	78
N+5	56.9	27.7	10.8	4.6	22.2	65
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.6	57.1	23.2	0.0	0.0	56
N+1	40.0	15.6	35.6	8.9	8.9	45
N+2	37.5	8.3	33.3	20.8	27.9	24
N+3	43.8	31.3	18.8	6.3	32.4	16
N+4	18.2	45.5	27.3	9.1	38.5	11
N+5	22.2	22.2	44.4	11.1	45.4	9
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.3	6.3	87.5	0.0	0.0	16
N+1	0.0	0.0	75.0	25.0	25.0	8
N+2	0.0	0.0	25.0	75.0	81.3	4
N+3	0.0	0.0	100.0	0.0	81.3	1
N+4	0.0	0.0	100.0	0.0	81.3	1
N+5	0.0	0.0	0.0	0.0	81.3	0

TABLE 49.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	68.0	16.0	8.0	8.0	8.0	25
N+1	83.3	0.0	16.7	0.0	8.0	18
N+2	71.4	7.1	21.4	0.0	8.0	14
N+3	45.5	18.2	18.2	18.2	24.7	11
N+4	42.9	28.6	14.3	14.3	35.5	7
N+5	66.7	16.7	0.0	16.7	46.2	6
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	14.3	71.4	0.0	0.0	7
N+1	0.0	66.7	0.0	33.3	33.3	6
N+2	0.0	66.7	33.3	0.0	33.3	3
N+3	0.0	0.0	0.0	0.0	33.3	0
N+4	0.0	0.0	0.0	0.0	33.3	0
N+5	0.0	0.0	0.0	0.0	33.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	33.3	0.0	33.3	33.3	33.3	3
N+1	50.0	0.0	50.0	0.0	33.3	2
N+2	0.0	0.0	100.0	0.0	33.3	1
N+3	0.0	0.0	0.0	0.0	33.3	0
N+4	0.0	0.0	0.0	0.0	33.3	0
N+5	0.0	0.0	0.0	0.0	33.3	0

TABLE 50.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.0	35.1	3.9	0.0	0.0	77
N+1	46.5	29.6	21.1	2.8	2.8	71
N+2	45.6	29.8	19.3	5.3	7.9	57
N+3	35.7	31.0	28.6	4.8	12.3	42
N+4	30.0	40.0	20.0	10.0	21.1	30
N+5	32.0	48.0	20.0	0.0	21.1	25
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.5	52.4	38.1	0.0	0.0	21
N+1	11.1	22.2	61.1	5.6	5.6	18
N+2	35.7	7.1	35.7	21.4	25.8	14
N+3	33.3	33.3	33.3	0.0	25.8	9
N+4	0.0	40.0	40.0	20.0	40.6	5
N+5	0.0	50.0	50.0	0.0	40.6	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	12
N+1	0.0	33.3	66.7	0.0	0.0	6
N+2	0.0	40.0	20.0	40.0	40.0	5
N+3	0.0	0.0	100.0	0.0	40.0	1
N+4	0.0	0.0	100.0	0.0	40.0	1
N+5	0.0	0.0	0.0	0.0	40.0	0

TABLE 51.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	68.2	27.3	4.5	0.0	0.0	22
N+1	53.8	23.1	15.4	7.7	7.7	13
N+2	66.7	16.7	8.3	8.3	15.4	12
N+3	80.0	10.0	10.0	0.0	15.4	10
N+4	100.0	0.0	0.0	0.0	15.4	3
N+5	100.0	0.0	0.0	0.0	15.4	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	90.0	10.0	0.0	0.0	10
N+1	33.3	55.6	11.1	0.0	0.0	9
N+2	66.7	22.2	11.1	0.0	0.0	9
N+3	77.8	22.2	0.0	0.0	0.0	9
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 52.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.9	5.1	0.0	0.0	0.0	79
N+1	90.0	8.3	1.7	0.0	0.0	60
N+2	91.3	8.7	0.0	0.0	0.0	46
N+3	81.3	18.8	0.0	0.0	0.0	32
N+4	80.0	20.0	0.0	0.0	0.0	25
N+5	84.2	10.5	5.3	0.0	0.0	19
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	22.2	68.9	8.9	0.0	0.0	45
N+1	46.3	39.0	12.2	2.4	2.4	41
N+2	54.5	33.3	12.1	0.0	2.4	33
N+3	51.7	34.5	13.8	0.0	2.4	29
N+4	66.7	22.2	11.1	0.0	2.4	27
N+5	63.2	26.3	10.5	0.0	2.4	19
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	14.3	71.4	14.3	14.3	28
N+1	5.3	15.8	78.9	0.0	14.3	19
N+2	12.5	12.5	75.0	0.0	14.3	16
N+3	7.7	23.1	69.2	0.0	14.3	13
N+4	30.0	10.0	60.0	0.0	14.3	10
N+5	20.0	20.0	60.0	0.0	14.3	5

TABLE 53.

BLACK OAK * INTERMECIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOC	FAIR	PCOR	CEAD	CUM. CEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCCD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	72.3	25.5	2.1	0.0	0.0	94
N+1	61.4	15.7	10.0	12.9	12.9	7C
N+2	66.7	17.6	7.8	7.8	19.7	51
N+3	60.5	21.1	13.2	5.3	23.9	38
N+4	52.0	24.0	24.0	0.0	23.9	25
N+5	56.5	13.0	26.1	4.3	27.2	23
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	24.0	40.0	36.0	0.0	0.0	25
N+1	7.1	35.7	42.9	14.3	14.3	14
N+2	33.3	11.1	44.4	11.1	23.8	9
N+3	0.0	0.0	100.0	0.0	23.8	1
N+4	0.0	0.0	100.0	0.0	23.8	1
N+5	0.0	0.0	100.0	0.0	23.8	1
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	7.1	0.0	85.7	7.1	7.1	14
N+1	11.1	0.0	44.4	44.4	48.4	9
N+2	0.0	20.0	80.0	0.0	48.4	5
N+3	0.0	0.0	100.0	0.0	48.4	4
N+4	0.0	0.0	100.0	0.0	48.4	4
N+5	0.0	0.0	100.0	0.0	48.4	3

TABLE 54.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.9	28.6	9.5	0.0	0.0	21
N+1	47.4	21.1	10.5	21.1	21.1	19
N+2	60.0	20.0	20.0	0.0	21.1	15
N+3	88.9	11.1	0.0	0.0	21.1	9
N+4	83.3	16.7	0.0	0.0	21.1	6
N+5	80.0	0.0	0.0	20.0	36.8	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	14.3	57.1	14.3	14.3	7
N+1	33.3	0.0	33.3	33.3	42.9	3
N+2	100.0	0.0	0.0	0.0	42.9	1
N+3	100.0	0.0	0.0	0.0	42.9	1
N+4	0.0	0.0	0.0	0.0	42.9	0
N+5	0.0	0.0	0.0	0.0	42.9	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 55.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	33.3	0.0	0.0	0.0	33
N+1	51.9	37.0	7.4	3.7	3.7	27
N+2	54.2	33.3	8.3	4.2	7.7	24
N+3	31.3	31.3	25.0	12.5	19.3	16
N+4	20.0	30.0	50.0	0.0	19.3	10
N+5	10.0	30.0	60.0	0.0	19.3	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.0	50.0	40.0	0.0	0.0	10
N+1	0.0	20.0	80.0	0.0	0.0	5
N+2	33.3	0.0	66.7	0.0	0.0	3
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.0	0.0	90.0	0.0	0.0	10
N+1	0.0	0.0	60.0	40.0	40.0	5
N+2	0.0	0.0	100.0	0.0	40.0	3
N+3	0.0	0.0	100.0	0.0	40.0	3
N+4	0.0	0.0	100.0	0.0	40.0	3
N+5	0.0	0.0	100.0	0.0	40.0	2

TABLE 56.

BLACK OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.8	4.2	0.0	0.0	0.0	24
N+1	89.5	10.5	0.0	0.0	0.0	19
N+2	78.6	14.3	7.1	0.0	0.0	14
N+3	84.6	15.4	0.0	0.0	0.0	13
N+4	90.9	9.1	0.0	0.0	0.0	11
N+5	83.3	16.7	0.0	0.0	0.0	6
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	21.4	64.3	7.1	7.1	7.1	14
N+1	33.3	58.3	8.3	0.0	7.1	12
N+2	25.0	58.3	16.7	0.0	7.1	12
N+3	33.3	58.3	8.3	0.0	7.1	12
N+4	25.0	62.5	12.5	0.0	7.1	8
N+5	0.0	80.0	20.0	0.0	7.1	5
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	18.8	81.3	0.0	0.0	16
N+1	7.7	15.4	76.9	0.0	0.0	13
N+2	8.3	25.0	66.7	0.0	0.0	12
N+3	9.1	54.5	36.4	0.0	0.0	11
N+4	9.1	36.4	54.5	0.0	0.0	11
N+5	20.0	20.0	60.0	0.0	0.0	5

TABLE 57.

BLACK OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.3	17.6	8.1	0.0	0.0	74
N+1	52.4	15.9	15.9	15.9	15.9	63
N+2	43.9	26.8	19.5	9.8	24.1	41
N+3	34.6	34.6	26.9	3.8	27.0	26
N+4	38.1	19.0	28.6	14.3	37.4	21
N+5	41.2	5.9	41.2	11.8	44.8	17
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	31.0	40.5	23.8	4.8	4.8	42
N+1	40.0	16.7	20.0	23.3	27.0	30
N+2	31.3	31.3	18.8	18.8	40.7	16
N+3	22.2	33.3	33.3	11.1	47.3	9
N+4	16.7	16.7	66.7	0.0	47.3	6
N+5	16.7	33.3	33.3	16.7	56.1	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	8.0	92.0	0.0	0.0	25
N+1	0.0	6.7	40.0	53.3	53.3	15
N+2	0.0	0.0	100.0	0.0	53.3	4
N+3	0.0	0.0	50.0	50.0	76.7	4
N+4	0.0	50.0	50.0	0.0	76.7	2
N+5	0.0	50.0	0.0	50.0	88.3	2

TABLE 58.

BLACK OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	81.8	13.6	4.5	0.0	0.0	22
N+1	60.0	26.7	13.3	0.0	0.0	15
N+2	50.0	14.3	35.7	0.0	0.0	14
N+3	55.6	22.2	22.2	0.0	0.0	9
N+4	50.0	12.5	37.5	0.0	0.0	8
N+5	50.0	12.5	37.5	0.0	0.0	8
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	5.9	52.9	41.2	0.0	0.0	17
N+1	14.3	35.7	28.6	21.4	21.4	14
N+2	9.1	45.5	36.4	9.1	28.6	11
N+3	0.0	40.0	40.0	20.0	42.9	5
N+4	0.0	50.0	50.0	0.0	42.9	2
N+5	0.0	50.0	50.0	0.0	42.9	2
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	10
N+1	0.0	0.0	60.0	40.0	40.0	5
N+2	0.0	0.0	100.0	0.0	40.0	2
N+3	0.0	0.0	100.0	0.0	40.0	2
N+4	0.0	50.0	50.0	0.0	40.0	2
N+5	0.0	50.0	0.0	50.0	70.0	2

TABLE 59.

BLACK OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.8	0.0	4.2	0.0	0.0	24
N+1	94.7	5.3	0.0	0.0	0.0	19
N+2	94.4	5.6	0.0	0.0	0.0	18
N+3	94.1	5.9	0.0	0.0	0.0	17
N+4	86.7	13.3	0.0	0.0	0.0	15
N+5	91.7	8.3	0.0	0.0	0.0	12
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	20.0	66.7	13.3	0.0	0.0	15
N+1	28.6	50.0	14.3	7.1	7.1	14
N+2	42.9	57.1	0.0	0.0	7.1	7
N+3	42.9	57.1	0.0	0.0	7.1	7
N+4	66.7	33.3	0.0	0.0	7.1	6
N+5	50.0	50.0	0.0	0.0	7.1	4
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	12.5	62.5	25.0	25.0	16
N+1	0.0	10.0	80.0	10.0	32.5	10
N+2	0.0	16.7	83.3	0.0	32.5	6
N+3	0.0	33.3	66.7	0.0	32.5	6
N+4	0.0	40.0	60.0	0.0	32.5	5
N+5	0.0	0.0	100.0	0.0	32.5	3

TABLE 60.

BLACK OAK * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	31.8	59.1	9.1	0.0	0.0	22
N+1	68.4	26.3	5.3	0.0	0.0	19
N+2	73.3	13.3	13.3	0.0	0.0	15
N+3	44.4	44.4	11.1	0.0	0.0	9
N+4	83.3	16.7	0.0	0.0	0.0	6
N+5	66.7	33.3	0.0	0.0	0.0	6
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	28.6	57.1	0.0	0.0	7
N+1	0.0	0.0	75.0	25.0	25.0	4
N+2	0.0	0.0	66.7	33.3	50.0	3
N+3	0.0	0.0	100.0	0.0	50.0	1
N+4	0.0	0.0	100.0	0.0	50.0	1
N+5	0.0	0.0	100.0	0.0	50.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	50.0	50.0	0.0	0.0	4
N+1	0.0	50.0	50.0	0.0	0.0	2
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 61.

SCARLET OAK

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.1	28.9	4.9	1.1	1.1	637
N+1	65.8	16.5	8.7	9.0	10.0	553
N+2	68.1	17.6	9.7	4.6	14.2	392
N+3	57.4	23.5	16.7	2.4	16.2	251
N+4	57.8	26.5	14.2	1.4	17.4	211
N+5	53.9	28.7	17.4	0.0	17.4	178
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.0	68.4	16.2	1.3	1.3	228
N+1	38.6	26.5	20.1	14.8	15.9	189
N+2	41.1	23.2	21.4	14.3	27.9	112
N+3	41.7	31.9	23.6	2.8	29.9	72
N+4	60.7	14.8	21.3	3.3	32.2	61
N+5	28.6	33.3	33.3	4.8	35.5	21
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.9	9.3	85.2	3.7	3.7	54
N+1	2.9	11.8	44.1	41.2	43.4	34
N+2	20.0	0.0	70.0	10.0	49.0	10
N+3	0.0	0.0	100.0	0.0	49.0	5
N+4	0.0	0.0	100.0	0.0	49.0	5
N+5	0.0	0.0	100.0	0.0	49.0	5

TABLE 62.

SCARLET OAK

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	63.5	17.5	11.1	7.9	7.9	63
N+1	64.7	9.8	15.7	9.8	17.0	51
N+2	57.9	10.5	23.7	7.9	23.5	38
N+3	61.3	16.1	19.4	3.2	26.0	31
N+4	44.4	37.0	14.8	3.7	28.7	27
N+5	42.1	36.8	21.1	0.0	28.7	19
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.3	43.3	26.7	16.7	16.7	30
N+1	11.1	33.3	16.7	38.9	49.1	18
N+2	25.0	0.0	37.5	37.5	68.2	8
N+3	0.0	0.0	100.0	0.0	68.2	1
N+4	0.0	0.0	100.0	0.0	68.2	1
N+5	0.0	0.0	100.0	0.0	68.2	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	21.4	78.6	0.0	0.0	14
N+1	0.0	11.1	44.4	44.4	44.4	9
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 63.

SCARLET OAK

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	84.0	12.6	3.3	0.0	0.0	269
N+1	75.4	15.9	4.5	4.2	4.2	264
N+2	72.4	20.2	5.9	1.5	5.6	203
N+3	55.4	28.5	14.6	1.5	7.0	130
N+4	50.0	29.8	18.4	1.8	8.7	114
N+5	45.5	32.7	21.8	0.0	8.7	110
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.8	67.3	10.9	0.0	0.0	55
N+1	11.4	50.0	27.3	11.4	11.4	44
N+2	25.0	31.3	21.9	21.9	30.8	32
N+3	20.0	33.3	46.7	0.0	30.8	15
N+4	0.0	41.7	41.7	16.7	42.3	12
N+5	0.0	50.0	50.0	0.0	42.3	10
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	7.4	92.6	0.0	0.0	27
N+1	0.0	13.3	46.7	40.0	40.0	15
N+2	16.7	0.0	83.3	0.0	40.0	6
N+3	0.0	0.0	100.0	0.0	40.0	4
N+4	0.0	0.0	100.0	0.0	40.0	4
N+5	0.0	0.0	100.0	0.0	40.0	4

TABLE 64.

SCARLET OAK

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	58.1	28.4	13.5	0.0	0.0	74
N+1	17.9	30.4	41.1	10.7	10.7	56
N+2	24.5	26.5	42.9	6.1	16.2	49
N+3	27.3	22.7	45.5	4.5	20.0	44
N+4	42.9	28.6	28.6	0.0	20.0	14
N+5	46.2	30.8	23.1	0.0	20.0	13
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.4	56.5	13.0	13.0	13.0	23
N+1	0.0	64.7	23.5	11.8	23.3	17
N+2	33.3	46.7	13.3	6.7	28.4	15
N+3	33.3	33.3	0.0	33.3	52.3	3
N+4	0.0	100.0	0.0	0.0	52.3	1
N+5	0.0	0.0	0.0	0.0	52.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	60.0	20.0	20.0	5
N+1	0.0	25.0	50.0	25.0	40.0	4
N+2	33.3	33.3	33.3	0.0	40.0	3
N+3	0.0	0.0	0.0	0.0	40.0	0
N+4	0.0	0.0	0.0	0.0	40.0	0
N+5	0.0	0.0	0.0	0.0	40.0	0

TABLE 65.

SCARLET OAK

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	42.9	38.1	9.5	9.5	9.5	21
N+1	57.9	15.8	26.3	0.0	9.5	19
N+2	68.8	0.0	18.8	12.5	20.8	16
N+3	58.3	16.7	25.0	0.0	20.8	12
N+4	27.3	54.5	18.2	0.0	20.8	11
N+5	30.0	40.0	30.0	0.0	20.8	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	42.9	28.6	14.3	14.3	14
N+1	20.0	20.0	10.0	50.0	57.1	10
N+2	25.0	0.0	50.0	25.0	67.9	4
N+3	0.0	0.0	100.0	0.0	67.9	1
N+4	0.0	0.0	100.0	0.0	67.9	1
N+5	0.0	0.0	100.0	0.0	67.9	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	27.3	72.7	0.0	0.0	11
N+1	0.0	14.3	57.1	28.6	28.6	7
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 66.

SCARLET OAK

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.3	6.3	0.4	0.0	0.0	238
N+1	84.1	10.4	5.5	0.0	0.0	201
N+2	71.4	13.6	13.6	1.4	1.4	147
N+3	65.9	18.5	15.6	0.0	1.4	135
N+4	65.3	17.8	16.9	0.0	1.4	118
N+5	53.9	21.3	24.7	0.0	1.4	89
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	13.3	76.3	10.4	0.0	0.0	135
N+1	34.6	46.2	19.2	0.0	0.0	104
N+2	29.7	47.3	23.0	0.0	0.0	74
N+3	35.8	38.8	25.4	0.0	0.0	67
N+4	50.0	26.6	23.4	0.0	0.0	64
N+5	34.3	28.6	34.3	2.9	2.9	35
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	10.2	88.9	0.9	0.9	108
N+1	1.1	25.3	72.4	1.1	2.1	87
N+2	1.4	33.3	62.3	2.9	4.9	69
N+3	3.6	43.6	52.7	0.0	4.9	55
N+4	16.0	46.0	36.0	2.0	6.8	50
N+5	15.4	42.3	42.3	0.0	6.8	26

TABLE 67.

SCARLET OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	72.0	22.3	4.0	1.7	1.7	175
N+1	74.4	17.7	5.5	2.4	4.1	164
N+2	71.8	18.5	8.1	1.6	5.7	124
N+3	53.6	26.2	19.0	1.2	6.8	84
N+4	58.5	29.2	12.3	0.0	6.8	65
N+5	50.9	26.3	22.8	0.0	6.8	57
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.3	79.7	12.5	1.6	1.6	64
N+1	42.9	21.4	19.6	16.1	17.4	56
N+2	64.9	10.8	13.5	10.8	26.3	37
N+3	57.7	26.9	15.4	0.0	26.3	26
N+4	78.3	13.0	8.7	0.0	26.3	23
N+5	20.0	60.0	20.0	0.0	26.3	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	16.7	83.3	0.0	0.0	6
N+1	0.0	0.0	25.0	75.0	75.0	4
N+2	0.0	0.0	100.0	0.0	75.0	1
N+3	0.0	0.0	100.0	0.0	75.0	1
N+4	0.0	0.0	100.0	0.0	75.0	1
N+5	0.0	0.0	100.0	0.0	75.0	1

TABLE 68.

SCARLET OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	94.0	6.0	0.0	0.0	0.0	100
N+1	86.9	12.1	1.0	0.0	0.0	99
N+2	81.1	16.2	2.7	0.0	0.0	74
N+3	53.1	30.6	14.3	2.0	2.0	49
N+4	48.8	32.6	18.6	0.0	2.0	43
N+5	41.5	29.3	29.3	0.0	2.0	41
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	71.4	14.3	0.0	0.0	14
N+1	23.1	38.5	38.5	0.0	0.0	13
N+2	20.0	50.0	10.0	20.0	20.0	10
N+3	20.0	60.0	20.0	0.0	20.0	5
N+4	0.0	75.0	25.0	0.0	20.0	4
N+5	0.0	75.0	25.0	0.0	20.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 69.

SCARLET OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.6	30.3	9.1	0.0	0.0	33
N+1	24.1	34.5	34.5	6.9	6.9	29
N+2	29.6	25.9	40.7	3.7	10.3	27
N+3	30.8	19.2	50.0	0.0	10.3	26
N+4	50.0	16.7	33.3	0.0	10.3	6
N+5	60.0	20.0	20.0	0.0	10.3	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	50.0	50.0	0.0	0.0	6
N+1	0.0	60.0	0.0	40.0	40.0	5
N+2	33.3	66.7	0.0	0.0	40.0	3
N+3	0.0	0.0	0.0	0.0	40.0	0
N+4	0.0	0.0	0.0	0.0	40.0	0
N+5	0.0	0.0	0.0	0.0	40.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 70.

SCARLET OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.8	7.2	0.0	0.0	0.0	69
N+1	92.7	5.5	1.8	0.0	0.0	55
N+2	78.0	12.2	9.8	0.0	0.0	41
N+3	70.3	16.2	13.5	0.0	0.0	37
N+4	66.7	16.7	16.7	0.0	0.0	30
N+5	52.4	14.3	33.3	0.0	0.0	21
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	8.3	69.4	22.2	0.0	0.0	36
N+1	36.0	48.0	16.0	0.0	0.0	25
N+2	23.5	41.2	35.3	0.0	0.0	17
N+3	28.6	35.7	35.7	0.0	0.0	14
N+4	38.5	30.8	30.8	0.0	0.0	13
N+5	22.2	22.2	55.6	0.0	0.0	9
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	4.0	96.0	0.0	0.0	25
N+1	0.0	28.6	71.4	0.0	0.0	21
N+2	0.0	31.3	68.8	0.0	0.0	16
N+3	0.0	41.7	58.3	0.0	0.0	12
N+4	8.3	58.3	33.3	0.0	0.0	12
N+5	0.0	60.0	40.0	0.0	0.0	5

TABLE 71.

SCARLET OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	64.1	33.3	2.6	0.0	0.0	195
N+1	78.5	9.8	4.9	6.7	6.7	163
N+2	78.2	14.5	4.8	2.4	9.0	124
N+3	74.4	14.0	11.6	0.0	9.0	86
N+4	68.3	20.7	8.5	2.4	11.2	82
N+5	64.2	23.9	11.9	0.0	11.2	67
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.3	67.4	16.3	0.0	0.0	43
N+1	31.3	40.6	21.9	6.3	6.3	32
N+2	33.3	38.1	14.3	14.3	19.6	21
N+3	20.0	60.0	20.0	0.0	19.6	10
N+4	33.3	44.4	22.2	0.0	19.6	9
N+5	20.0	60.0	20.0	0.0	19.6	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	80.0	0.0	0.0	5
N+1	0.0	40.0	0.0	60.0	60.0	5
N+2	0.0	0.0	0.0	0.0	60.0	0
N+3	0.0	0.0	0.0	0.0	60.0	0
N+4	0.0	0.0	0.0	0.0	60.0	0
N+5	0.0	0.0	0.0	0.0	60.0	0

TABLE 72.

SCARLET OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	72.4	20.7	3.4	3.4	3.4	29
N+1	73.1	11.5	7.7	7.7	10.9	26
N+2	80.0	10.0	5.0	5.0	15.3	20
N+3	77.8	16.7	5.6	0.0	15.3	18
N+4	68.8	31.3	0.0	0.0	15.3	16
N+5	66.7	25.0	8.3	0.0	15.3	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.0	50.0	40.0	0.0	0.0	10
N+1	11.1	33.3	11.1	44.4	44.4	9
N+2	0.0	0.0	66.7	33.3	63.0	3
N+3	0.0	0.0	0.0	0.0	63.0	0
N+4	0.0	0.0	0.0	0.0	63.0	0
N+5	0.0	0.0	0.0	0.0	63.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 73.

SCARLET OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.5	12.9	1.6	0.0	0.0	62
N+1	80.6	14.5	4.8	0.0	0.0	62
N+2	75.0	16.1	7.1	1.8	1.8	56
N+3	64.3	19.0	16.7	0.0	1.8	42
N+4	59.0	20.5	15.4	5.1	6.8	39
N+5	59.5	24.3	16.2	0.0	6.8	37
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	23.5	70.6	5.9	0.0	0.0	17
N+1	0.0	54.5	36.4	9.1	9.1	11
N+2	22.2	33.3	22.2	22.2	29.3	9
N+3	0.0	66.7	33.3	0.0	29.3	3
N+4	0.0	66.7	33.3	0.0	29.3	3
N+5	0.0	66.7	33.3	0.0	29.3	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	0.0	100.0	100.0	3
N+2	0.0	0.0	0.0	0.0	100.0	C
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 74.

SCARLET OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.4	5.6	0.0	0.0	0.0	89
N+1	76.8	13.4	9.8	0.0	0.0	82
N+2	63.6	18.2	18.2	0.0	0.0	66
N+3	55.7	23.0	21.3	0.0	0.0	61
N+4	55.2	25.9	19.0	0.0	0.0	58
N+5	46.8	31.9	21.3	0.0	0.0	47
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	10.3	82.8	6.9	0.0	0.0	58
N+1	31.8	45.5	22.7	0.0	0.0	44
N+2	30.6	52.8	16.7	0.0	0.0	36
N+3	39.4	45.5	15.2	0.0	0.0	33
N+4	59.4	25.0	15.6	0.0	0.0	32
N+5	40.0	40.0	13.3	6.7	6.7	15
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	7.9	92.1	0.0	0.0	38
N+1	2.9	29.4	67.6	0.0	0.0	34
N+2	0.0	32.3	64.5	3.2	3.2	31
N+3	3.7	37.0	59.3	0.0	3.2	27
N+4	17.4	43.5	39.1	0.0	3.2	23
N+5	14.3	35.7	50.0	0.0	3.2	14

TABLE 75.

SCARLET OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.9	31.8	6.7	0.6	0.6	179
N+1	55.2	21.4	11.7	11.7	12.2	154
N+2	56.7	22.1	15.4	5.8	17.2	104
N+3	39.7	31.0	20.7	8.6	24.4	58
N+4	42.6	31.9	23.4	2.1	26.0	47
N+5	41.0	38.5	20.5	0.0	26.0	39
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.4	70.1	9.0	1.5	1.5	67
N+1	41.9	27.4	16.1	14.5	15.8	62
N+2	35.9	33.3	17.9	12.8	26.6	39
N+3	42.9	32.1	25.0	0.0	26.6	28
N+4	64.0	8.0	20.0	8.0	32.5	25
N+5	57.1	0.0	28.6	14.3	42.1	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.0	0.0	90.0	5.0	5.0	20
N+1	6.7	6.7	73.3	13.3	17.7	15
N+2	33.3	0.0	66.7	0.0	17.7	6
N+3	0.0	0.0	100.0	0.0	17.7	2
N+4	0.0	0.0	100.0	0.0	17.7	2
N+5	0.0	0.0	100.0	0.0	17.7	2

TABLE 76.

SCARLET CAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	75.6	18.3	6.1	0.0	0.0	82
N+1	62.5	21.2	6.3	10.0	10.0	80
N+2	58.5	30.2	7.5	3.8	13.4	53
N+3	42.3	38.5	15.4	3.8	16.7	26
N+4	40.9	36.4	22.7	0.0	16.7	22
N+5	31.8	45.5	22.7	0.0	16.7	22
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	26.7	60.0	13.3	0.0	0.0	15
N+1	7.1	50.0	14.3	28.6	28.6	14
N+2	37.5	12.5	25.0	25.0	46.4	8
N+3	20.0	0.0	80.0	0.0	46.4	5
N+4	0.0	0.0	50.0	50.0	73.2	4
N+5	0.0	0.0	100.0	0.0	73.2	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	10
N+1	0.0	14.3	71.4	14.3	14.3	7
N+2	25.0	0.0	75.0	0.0	14.3	4
N+3	0.0	0.0	100.0	0.0	14.3	2
N+4	0.0	0.0	100.0	0.0	14.3	2
N+5	0.0	0.0	100.0	0.0	14.3	2

TABLE 77.

SCARLET OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	46.4	35.7	17.9	0.0	0.0	28
N+1	4.5	22.7	59.1	13.6	13.6	22
N+2	11.1	22.2	55.6	11.1	23.2	18
N+3	14.3	28.6	42.9	14.3	34.2	14
N+4	50.0	25.0	25.0	0.0	34.2	4
N+5	50.0	25.0	25.0	0.0	34.2	4
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	33.3	55.6	0.0	11.1	11.1	9
N+1	0.0	75.0	25.0	0.0	11.1	8
N+2	25.0	37.5	25.0	12.5	22.2	8
N+3	0.0	50.0	0.0	50.0	61.1	2
N+4	0.0	100.0	0.0	0.0	61.1	1
N+5	0.0	0.0	0.0	0.0	61.1	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	66.7	33.3	33.3	3
N+1	0.0	0.0	50.0	50.0	66.7	2
N+2	0.0	0.0	100.0	0.0	66.7	1
N+3	0.0	0.0	0.0	0.0	66.7	0
N+4	0.0	0.0	0.0	0.0	66.7	0
N+5	0.0	0.0	0.0	0.0	66.7	0

TABLE 78.

SCARLET CAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.6	5.6	1.9	0.0	0.0	54
N+1	84.1	13.6	2.3	0.0	0.0	44
N+2	78.8	9.1	9.1	3.0	3.0	33
N+3	80.6	9.7	9.7	0.0	3.0	31
N+4	84.6	0.0	15.4	0.0	3.0	26
N+5	73.7	0.0	26.3	0.0	3.0	19
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	12.0	80.0	8.0	0.0	0.0	25
N+1	36.4	40.9	22.7	0.0	0.0	22
N+2	38.9	33.3	27.8	0.0	0.0	18
N+3	41.2	17.6	41.2	0.0	0.0	17
N+4	50.0	12.5	37.5	0.0	0.0	16
N+5	36.4	18.2	45.5	0.0	0.0	11
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	8.3	87.5	4.2	4.2	24
N+1	0.0	14.3	85.7	0.0	4.2	14
N+2	8.3	33.3	50.0	8.3	12.2	12
N+3	14.3	57.1	28.6	0.0	12.2	7
N+4	28.6	42.9	28.6	0.0	12.2	7
N+5	50.0	25.0	25.0	0.0	12.2	4

TABLE 79.

SCARLET CAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	72.3	23.4	2.1	2.1	2.1	47
N+1	44.7	18.4	10.5	26.3	27.9	38
N+2	58.8	5.9	23.5	11.8	36.4	17
N+3	55.6	22.2	22.2	0.0	36.4	9
N+4	50.0	25.0	25.0	0.0	36.4	8
N+5	50.0	50.0	0.0	0.0	36.4	6
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.6	55.6	38.9	0.0	0.0	18
N+1	36.4	27.3	27.3	9.1	9.1	11
N+2	0.0	20.0	60.0	20.0	27.3	5
N+3	0.0	33.3	66.7	0.0	27.3	3
N+4	0.0	0.0	100.0	0.0	27.3	2
N+5	0.0	50.0	50.0	0.0	27.3	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	75.0	0.0	0.0	8
N+1	0.0	0.0	66.7	33.3	33.3	3
N+2	0.0	0.0	50.0	50.0	66.7	2
N+3	0.0	0.0	100.0	0.0	66.7	1
N+4	0.0	0.0	100.0	0.0	66.7	1
N+5	0.0	0.0	100.0	0.0	66.7	1

TABLE 80.

SCARLET CAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	51.3	28.2	15.4	5.1	5.1	39
N+1	34.4	15.6	28.1	21.9	25.9	32
N+2	47.6	19.0	9.5	23.8	43.5	21
N+3	46.2	38.5	15.4	0.0	43.5	13
N+4	37.5	37.5	25.0	0.0	43.5	8
N+5	50.0	25.0	25.0	0.0	43.5	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	22.6	48.4	25.8	3.2	3.2	31
N+1	37.5	12.5	20.8	29.2	31.5	24
N+2	12.5	0.0	50.0	37.5	57.2	8
N+3	25.0	0.0	25.0	50.0	78.6	4
N+4	0.0	0.0	100.0	0.0	78.6	1
N+5	0.0	0.0	100.0	0.0	78.6	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	9.1	90.9	0.0	0.0	11
N+1	0.0	16.7	16.7	66.7	66.7	6
N+2	0.0	0.0	100.0	0.0	66.7	1
N+3	0.0	0.0	100.0	0.0	66.7	1
N+4	0.0	0.0	100.0	0.0	66.7	1
N+5	0.0	0.0	100.0	0.0	66.7	1

TABLE 81.

WHITE OAK

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.3	25.4	13.2	0.1	0.1	1364
N+1	60.8	20.5	10.8	7.9	8.1	982
N+2	60.4	21.8	12.5	5.2	12.9	710
N+3	53.9	23.5	20.2	2.4	15.0	456
N+4	52.9	24.9	20.8	1.4	16.1	361
N+5	59.1	19.4	20.2	1.2	17.2	242
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.8	42.9	38.0	1.3	1.3	595
N+1	22.0	24.6	36.8	16.6	17.7	427
N+2	28.2	23.3	38.0	10.6	26.5	245
N+3	31.5	18.5	45.2	4.8	30.0	146
N+4	24.7	18.6	54.6	2.1	31.4	97
N+5	13.2	25.0	60.3	1.5	32.5	68
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.3	6.3	89.1	3.3	3.3	479
N+1	1.6	4.6	63.4	30.4	32.7	306
N+2	4.1	5.5	74.5	15.9	43.4	145
N+3	3.6	7.1	83.3	6.0	46.8	84
N+4	3.4	8.6	81.0	6.9	50.4	58
N+5	6.8	9.1	84.1	0.0	50.4	44

TABLE 82.

WHITE OAK

DEFOLIATION HISTORY--HH

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	49.0	24.7	22.4	3.8	3.8	263
N+1	46.5	21.0	19.1	13.4	16.7	157
N+2	50.5	12.1	30.3	7.1	22.6	99
N+3	37.9	22.4	37.9	1.7	23.9	58
N+4	26.7	23.3	50.0	0.0	23.9	30
N+5	35.7	35.7	21.4	7.1	29.3	14
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	18.8	25.0	53.1	3.1	3.1	96
N+1	11.8	21.6	33.3	33.3	35.4	51
N+2	11.5	19.2	50.0	19.2	47.8	26
N+3	18.2	18.2	45.5	18.2	57.3	11
N+4	50.0	25.0	0.0	25.0	68.0	4
N+5	0.0	100.0	0.0	0.0	68.0	1
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	4.2	11.3	71.8	12.7	12.7	71
N+1	4.8	2.4	45.2	47.6	54.3	42
N+2	10.0	0.0	70.0	20.0	63.4	10
N+3	14.3	14.3	71.4	0.0	63.4	7
N+4	0.0	0.0	100.0	0.0	63.4	3
N+5	0.0	0.0	100.0	0.0	63.4	2

TABLE 83.

WHITE OAK

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.4	16.3	44.9	18.4	18.4	49
N+1	5.9	11.8	35.3	47.1	56.8	17
N+2	0.0	0.0	75.0	25.0	67.6	4
N+3	0.0	0.0	0.0	0.0	67.6	0
N+4	0.0	0.0	0.0	0.0	67.6	0
N+5	0.0	0.0	0.0	0.0	67.6	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.1	18.2	54.5	18.2	18.2	22
N+1	0.0	10.0	40.0	50.0	59.1	10
N+2	0.0	0.0	100.0	0.0	59.1	4
N+3	0.0	0.0	100.0	0.0	59.1	2
N+4	0.0	0.0	0.0	100.0	100.0	1
N+5	0.0	0.0	0.0	0.0	100.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	90.0	10.0	10.0	10
N+1	0.0	25.0	50.0	25.0	32.5	4
N+2	0.0	0.0	100.0	0.0	32.5	2
N+3	0.0	0.0	100.0	0.0	32.5	1
N+4	0.0	0.0	100.0	0.0	32.5	1
N+5	0.0	0.0	0.0	0.0	32.5	0

TABLE 84.

WHITE OAK

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	70.5	21.2	7.9	0.4	0.4	458
N+1	67.2	20.4	10.2	2.3	2.7	393
N+2	65.1	19.6	12.2	3.2	5.8	312
N+3	62.3	22.6	13.2	1.9	7.6	212
N+4	65.4	19.2	15.4	0.0	7.6	182
N+5	63.2	19.5	17.3	0.0	7.6	133
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.6	45.8	38.3	1.2	1.2	253
N+1	21.1	24.6	46.2	8.0	9.1	199
N+2	22.8	24.8	43.0	9.4	17.7	149
N+3	29.9	24.1	44.8	1.1	18.6	87
N+4	26.1	20.3	53.6	0.0	18.6	69
N+5	14.3	28.6	57.1	0.0	18.6	49
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.1	95.2	1.8	1.8	228
N+1	2.3	2.9	76.6	18.1	19.6	171
N+2	2.8	3.7	80.6	13.0	30.0	108
N+3	3.2	4.8	88.7	3.2	32.3	62
N+4	2.1	8.3	81.3	8.3	37.9	48
N+5	5.3	10.5	84.2	0.0	37.9	38

TABLE 85.

WHITE OAK

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	53.8	22.2	18.8	5.1	5.1	117
N+1	42.9	22.9	21.4	12.9	17.3	70
N+2	57.1	18.4	12.2	12.2	27.4	49
N+3	60.0	15.0	15.0	10.0	34.7	20
N+4	100.0	0.0	0.0	0.0	34.7	2
N+5	100.0	0.0	0.0	0.0	34.7	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.3	43.5	47.8	4.3	4.3	69
N+1	0.0	36.7	51.0	12.2	16.1	49
N+2	6.5	29.0	54.8	9.7	24.2	31
N+3	40.0	26.7	33.3	0.0	24.2	15
N+4	0.0	40.0	60.0	0.0	24.2	5
N+5	0.0	25.0	75.0	0.0	24.2	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.2	95.8	0.0	0.0	24
N+1	0.0	0.0	72.7	27.3	27.3	11
N+2	0.0	0.0	100.0	0.0	27.3	8
N+3	0.0	0.0	100.0	0.0	27.3	6
N+4	0.0	0.0	100.0	0.0	27.3	2
N+5	0.0	0.0	100.0	0.0	27.3	2

TABLE 86.

WHITE OAK

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.9	29.2	21.3	4.5	4.5	89
N+1	38.8	23.9	25.4	11.9	15.9	67
N+2	52.3	15.9	31.8	0.0	15.9	44
N+3	52.6	21.1	21.1	5.3	20.3	19
N+4	33.3	33.3	33.3	0.0	20.3	9
N+5	20.0	60.0	20.0	0.0	20.3	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	7.9	36.5	47.6	7.9	7.9	63
N+1	12.5	18.8	46.9	21.9	28.1	32
N+2	17.6	17.6	41.2	23.5	45.0	17
N+3	33.3	16.7	50.0	0.0	45.0	6
N+4	66.7	0.0	33.3	0.0	45.0	3
N+5	0.0	0.0	0.0	0.0	45.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	12.2	82.9	4.9	4.9	41
N+1	0.0	3.2	61.3	35.5	38.6	31
N+2	14.3	0.0	71.4	14.3	47.4	7
N+3	25.0	0.0	75.0	0.0	47.4	4
N+4	0.0	0.0	100.0	0.0	47.4	3
N+5	0.0	0.0	100.0	0.0	47.4	1

TABLE 87.

WHITE OAK

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.1	6.2	0.7	0.0	0.0	403
N+1	92.3	6.2	1.5	0.0	0.0	325
N+2	90.4	8.4	1.2	0.0	0.0	250
N+3	90.5	7.6	1.9	0.0	0.0	210
N+4	90.8	6.4	2.8	0.0	0.0	141
N+5	89.5	7.0	3.5	0.0	0.0	114
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	24.0	61.7	13.1	1.1	1.1	183
N+1	34.7	48.6	15.3	1.4	2.5	144
N+2	34.8	47.3	17.0	0.9	3.3	112
N+3	39.8	38.8	20.4	1.0	4.3	98
N+4	39.3	40.5	19.0	1.2	5.5	84
N+5	37.7	37.7	24.6	0.0	5.5	61
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	2.3	9.1	86.0	2.7	2.7	264
N+1	4.6	19.4	69.4	6.5	9.0	216
N+2	6.1	23.2	68.3	2.4	11.2	164
N+3	13.9	21.5	64.6	0.0	11.2	144
N+4	23.3	19.8	55.2	1.7	12.7	116
N+5	22.1	20.8	55.8	1.3	13.8	77

TABLE 88.

WHITE OAK * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	57.8	15.5	26.7	0.0	0.0	161
N+1	74.7	11.0	6.6	7.7	7.7	91
N+2	76.1	19.7	4.2	0.0	7.7	71
N+3	66.7	24.1	9.3	0.0	7.7	54
N+4	55.8	27.9	16.3	0.0	7.7	43
N+5	79.4	11.8	8.8	0.0	7.7	34
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.9	60.0	28.9	2.2	2.2	45
N+1	29.0	29.0	32.3	9.7	11.7	31
N+2	25.0	31.3	37.5	6.3	17.2	16
N+3	38.5	30.8	30.8	0.0	17.2	13
N+4	44.4	22.2	33.3	0.0	17.2	9
N+5	20.0	40.0	40.0	0.0	17.2	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.1	87.5	9.4	9.4	32
N+1	0.0	7.1	71.4	21.4	28.8	14
N+2	0.0	0.0	80.0	20.0	43.0	5
N+3	0.0	0.0	100.0	0.0	43.0	2
N+4	0.0	0.0	100.0	0.0	43.0	1
N+5	0.0	0.0	100.0	0.0	43.0	1

TABLE 89.

WHITE OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	29.2	37.5	8.3	8.3	24
N+1	53.8	7.7	23.1	15.4	22.4	13
N+2	66.7	22.2	11.1	0.0	22.4	9
N+3	25.0	25.0	50.0	0.0	22.4	4
N+4	0.0	50.0	50.0	0.0	22.4	4
N+5	66.7	0.0	33.3	0.0	22.4	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	50.0	25.0	25.0	4
N+1	0.0	0.0	0.0	0.0	25.0	0
N+2	0.0	0.0	0.0	0.0	25.0	0
N+3	0.0	0.0	0.0	0.0	25.0	0
N+4	0.0	0.0	0.0	0.0	25.0	0
N+5	0.0	0.0	0.0	0.0	25.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	5
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 90.

WHITE OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	84.6	9.2	4.6	1.5	1.5	65
N+1	83.0	7.5	5.7	3.8	5.3	53
N+2	78.9	15.8	5.3	0.0	5.3	38
N+3	73.3	20.0	6.7	0.0	5.3	30
N+4	73.1	19.2	7.7	0.0	5.3	26
N+5	81.0	14.3	4.8	0.0	5.3	21
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.4	64.3	14.3	0.0	0.0	14
N+1	33.3	41.7	25.0	0.0	0.0	12
N+2	40.0	30.0	30.0	0.0	0.0	10
N+3	55.6	22.2	22.2	0.0	0.0	9
N+4	57.1	14.3	28.6	0.0	0.0	7
N+5	25.0	50.0	25.0	0.0	0.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	10.0	90.0	0.0	0.0	10
N+1	0.0	16.7	83.3	0.0	0.0	6
N+2	0.0	0.0	75.0	25.0	25.0	4
N+3	0.0	0.0	100.0	0.0	25.0	1
N+4	0.0	0.0	100.0	0.0	25.0	1
N+5	0.0	0.0	100.0	0.0	25.0	1

TABLE 91.

WHITE OAK * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.9	4.1	0.0	0.0	0.0	73
N+1	94.8	5.2	0.0	0.0	0.0	58
N+2	95.6	4.4	0.0	0.0	0.0	45
N+3	100.0	0.0	0.0	0.0	0.0	36
N+4	100.0	0.0	0.0	0.0	0.0	29
N+5	100.0	0.0	0.0	0.0	0.0	22
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	53.3	33.3	13.3	0.0	0.0	15
N+1	60.0	20.0	20.0	0.0	0.0	10
N+2	66.7	16.7	16.7	0.0	0.0	6
N+3	66.7	16.7	16.7	0.0	0.0	6
N+4	66.7	16.7	16.7	0.0	0.0	6
N+5	66.7	0.0	33.3	0.0	0.0	3
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	27.3	72.7	0.0	0.0	11
N+1	12.5	50.0	37.5	0.0	0.0	8
N+2	37.5	25.0	37.5	0.0	0.0	8
N+3	62.5	12.5	25.0	0.0	0.0	8
N+4	71.4	14.3	14.3	0.0	0.0	7
N+5	80.0	0.0	20.0	0.0	0.0	5

TABLE 92.

WHITE OAK * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.0	23.0	12.0	0.0	0.0	400
N+1	70.1	17.0	10.7	2.2	2.2	224
N+2	79.0	12.7	7.6	0.6	2.9	157
N+3	70.8	17.9	11.3	0.0	2.9	106
N+4	72.7	16.9	10.4	0.0	2.9	77
N+5	70.7	17.1	12.2	0.0	2.9	41
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.9	47.5	37.6	0.0	0.0	101
N+1	22.6	33.9	38.7	4.8	4.8	62
N+2	33.3	16.7	41.7	8.3	12.8	36
N+3	47.6	14.3	38.1	0.0	12.8	21
N+4	20.0	20.0	60.0	0.0	12.8	10
N+5	0.0	25.0	75.0	0.0	12.8	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.2	92.3	1.5	1.5	65
N+1	0.0	3.1	90.6	6.3	7.7	32
N+2	5.3	0.0	89.5	5.3	12.6	19
N+3	7.1	14.3	78.6	0.0	12.6	14
N+4	0.0	11.1	88.9	0.0	12.6	9
N+5	12.5	0.0	87.5	0.0	12.6	8

TABLE 93.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.6	23.0	18.9	1.6	1.6	122
N+1	59.7	19.4	16.4	4.5	6.0	67
N+2	68.4	10.5	18.4	2.6	8.5	38
N+3	53.6	25.0	21.4	0.0	8.5	28
N+4	60.0	10.0	30.0	0.0	8.5	10
N+5	33.3	66.7	0.0	0.0	8.5	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.6	38.9	55.6	0.0	0.0	18
N+1	33.3	16.7	50.0	0.0	0.0	6
N+2	50.0	0.0	50.0	0.0	0.0	4
N+3	66.7	0.0	33.3	0.0	0.0	3
N+4	100.0	0.0	0.0	0.0	0.0	2
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	16.7	83.3	0.0	0.0	6
N+1	0.0	33.3	66.7	0.0	0.0	3
N+2	33.3	0.0	66.7	0.0	0.0	3
N+3	50.0	0.0	50.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 94.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	29.6	22.2	29.6	18.5	18.5	27
N+1	20.0	0.0	60.0	20.0	34.8	5
N+2	0.0	0.0	0.0	0.0	34.8	C
N+3	0.0	0.0	0.0	0.0	34.8	C
N+4	0.0	0.0	0.0	0.0	34.8	C
N+5	0.0	0.0	0.0	0.0	34.8	C
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	16.7	50.0	33.3	33.3	6
N+1	0.0	0.0	100.0	0.0	33.3	1
N+2	0.0	0.0	100.0	0.0	33.3	1
N+3	0.0	0.0	0.0	0.0	33.3	C
N+4	0.0	0.0	0.0	0.0	33.3	C
N+5	0.0	0.0	0.0	0.0	33.3	C
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	100.0	100.0	1
N+1	0.0	0.0	0.0	0.0	100.0	C
N+2	0.0	0.0	0.0	0.0	100.0	C
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 95.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	71.6	22.4	5.2	0.9	0.9	116
N+1	81.6	11.5	6.9	0.0	0.9	87
N+2	80.9	10.3	8.8	0.0	0.9	68
N+3	75.0	15.4	9.6	0.0	0.9	52
N+4	81.6	10.2	8.2	0.0	0.9	49
N+5	73.7	10.5	15.8	0.0	0.9	19
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.5	36.6	39.0	4.9	4.9	41
N+1	20.7	20.7	58.6	0.0	4.9	29
N+2	18.2	22.7	54.5	4.5	9.2	22
N+3	25.0	16.7	58.3	0.0	9.2	12
N+4	0.0	25.0	75.0	0.0	9.2	8
N+5	0.0	25.0	75.0	0.0	9.2	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	27
N+1	0.0	0.0	94.4	5.6	5.6	18
N+2	0.0	0.0	100.0	0.0	5.6	11
N+3	0.0	14.3	85.7	0.0	5.6	7
N+4	0.0	16.7	83.3	0.0	5.6	6
N+5	16.7	0.0	83.3	0.0	5.6	6

TABLE 96.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	64.5	19.4	12.9	3.2	3.2	31
N+1	66.7	22.2	11.1	0.0	3.2	18
N+2	83.3	16.7	0.0	0.0	3.2	12
N+3	80.0	20.0	0.0	0.0	3.2	5
N+4	0.0	0.0	0.0	0.0	3.2	0
N+5	0.0	0.0	0.0	0.0	3.2	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.1	54.5	36.4	0.0	0.0	11
N+1	0.0	44.4	55.6	0.0	0.0	9
N+2	20.0	20.0	40.0	20.0	20.0	5
N+3	50.0	50.0	0.0	0.0	20.0	2
N+4	0.0	0.0	0.0	0.0	20.0	0
N+5	0.0	0.0	0.0	0.0	20.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	6
N+1	0.0	0.0	100.0	0.0	0.0	3
N+2	0.0	0.0	100.0	0.0	0.0	3
N+3	0.0	0.0	100.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 97.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.4	36.1	16.7	2.8	2.8	36
N+1	46.2	26.9	26.9	0.0	2.8	26
N+2	55.0	5.0	40.0	0.0	2.8	20
N+3	66.7	16.7	16.7	0.0	2.8	12
N+4	60.0	20.0	20.0	0.0	2.8	5
N+5	100.0	0.0	0.0	0.0	2.8	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	40.0	60.0	0.0	0.0	15
N+1	50.0	0.0	50.0	0.0	0.0	4
N+2	66.7	0.0	33.3	0.0	0.0	3
N+3	66.7	0.0	33.3	0.0	0.0	3
N+4	100.0	0.0	0.0	0.0	0.0	2
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	33.3	66.7	0.0	0.0	3
N+1	0.0	33.3	66.7	0.0	0.0	3
N+2	33.3	0.0	66.7	0.0	0.0	3
N+3	50.0	0.0	50.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 98.

WHITE OAK * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.3	4.3	1.4	0.0	0.0	70
N+1	96.6	1.7	1.7	0.0	0.0	58
N+2	95.5	2.3	2.3	0.0	0.0	44
N+3	97.0	3.0	0.0	0.0	0.0	33
N+4	96.0	4.0	0.0	0.0	0.0	25
N+5	100.0	0.0	0.0	0.0	0.0	19
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	22.2	55.6	16.7	5.6	5.6	18
N+1	61.5	23.1	15.4	0.0	5.6	13
N+2	90.0	0.0	10.0	0.0	5.6	10
N+3	100.0	0.0	0.0	0.0	5.6	9
N+4	100.0	0.0	0.0	0.0	5.6	6
N+5	100.0	0.0	0.0	0.0	5.6	4
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	3.6	14.3	82.1	0.0	0.0	28
N+1	10.0	25.0	60.0	5.0	5.0	20
N+2	12.5	31.3	56.3	0.0	5.0	16
N+3	33.3	26.7	40.0	0.0	5.0	15
N+4	53.3	13.3	33.3	0.0	5.0	15
N+5	40.0	30.0	30.0	0.0	5.0	10

TABLE 99.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	67.2	22.4	9.9	0.5	0.5	415
N+1	64.5	15.9	10.4	9.2	9.7	346
N+2	59.9	17.9	13.2	8.9	17.8	257
N+3	54.4	19.4	23.3	2.8	20.1	180
N+4	57.2	20.7	21.4	0.7	20.6	145
N+5	61.6	18.2	18.2	2.0	22.2	99
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.1	50.0	27.3	2.6	2.6	154
N+1	29.8	19.0	27.3	24.0	25.9	121
N+2	36.1	23.0	32.8	8.2	32.0	61
N+3	43.9	14.6	36.6	4.9	35.3	41
N+4	37.9	13.8	48.3	0.0	35.3	29
N+5	29.4	11.8	58.8	0.0	35.3	17
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	7.4	83.0	9.6	9.6	94
N+1	1.8	3.5	61.4	33.3	39.7	57
N+2	3.8	3.8	65.4	26.9	55.9	26
N+3	6.7	6.7	80.0	6.7	58.9	15
N+4	0.0	0.0	88.9	11.1	63.5	9
N+5	0.0	14.3	85.7	0.0	63.5	7

TABLE 100.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	47.3	23.6	23.6	5.5	5.5	55
N+1	35.1	21.6	13.5	29.7	33.6	37
N+2	20.8	8.3	58.3	12.5	41.9	24
N+3	20.0	13.3	60.0	6.7	45.7	15
N+4	22.2	11.1	66.7	0.0	45.7	9
N+5	0.0	50.0	25.0	25.0	59.3	4
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	30.0	5.0	60.0	5.0	5.0	20
N+1	27.3	9.1	36.4	27.3	30.9	11
N+2	14.3	14.3	28.6	42.9	60.5	7
N+3	0.0	0.0	100.0	0.0	60.5	1
N+4	0.0	0.0	0.0	0.0	60.5	0
N+5	0.0	0.0	0.0	0.0	60.5	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	11.1	61.1	27.8	27.8	18
N+1	0.0	0.0	55.6	44.4	59.9	9
N+2	0.0	0.0	100.0	0.0	59.9	1
N+3	0.0	0.0	100.0	0.0	59.9	1
N+4	0.0	0.0	100.0	0.0	59.9	1
N+5	0.0	0.0	0.0	0.0	59.9	0

TABLE 101.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.5	17.2	8.3	0.0	0.0	145
N+1	72.1	13.2	10.3	4.4	4.4	136
N+2	71.2	12.5	8.7	7.7	11.8	104
N+3	69.0	18.3	11.3	1.4	13.0	71
N+4	71.4	15.9	12.7	0.0	13.0	63
N+5	70.2	15.8	14.0	0.0	13.0	57
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.2	58.6	24.1	0.0	0.0	58
N+1	28.8	21.2	36.5	13.5	13.5	52
N+2	32.4	23.5	35.3	8.8	21.1	34
N+3	47.8	17.4	30.4	4.3	24.5	23
N+4	50.0	11.1	38.9	0.0	24.5	18
N+5	36.4	18.2	45.5	0.0	24.5	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	2.1	97.9	0.0	0.0	47
N+1	2.9	2.9	70.6	23.5	23.5	34
N+2	5.0	5.0	60.0	30.0	46.5	20
N+3	9.1	9.1	81.8	0.0	46.5	11
N+4	0.0	0.0	87.5	12.5	53.2	8
N+5	0.0	14.3	85.7	0.0	53.2	7

TABLE 102.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.5	18.6	11.6	9.3	9.3	43
N+1	46.4	17.9	17.9	17.9	25.5	28
N+2	59.1	22.7	9.1	9.1	32.3	22
N+3	66.7	11.1	22.2	0.0	32.3	9
N+4	100.0	0.0	0.0	0.0	32.3	1
N+5	0.0	0.0	0.0	0.0	32.3	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	55.0	40.0	5.0	5.0	20
N+1	0.0	43.8	43.8	12.5	16.9	16
N+2	8.3	33.3	50.0	8.3	23.8	12
N+3	50.0	0.0	50.0	0.0	23.8	6
N+4	0.0	0.0	100.0	0.0	23.8	1
N+5	0.0	0.0	100.0	0.0	23.8	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	100.0	0.0	50.0	1
N+3	0.0	0.0	0.0	0.0	50.0	0
N+4	0.0	0.0	0.0	0.0	50.0	0
N+5	0.0	0.0	0.0	0.0	50.0	0

TABLE 103.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	91.6	8.4	0.0	0.0	0.0	155
N+1	88.6	10.6	0.8	0.0	0.0	123
N+2	85.9	12.0	2.2	0.0	0.0	92
N+3	86.4	9.9	3.7	0.0	0.0	81
N+4	83.3	8.3	8.3	0.0	0.0	48
N+5	81.6	7.9	10.5	0.0	0.0	38
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	24.5	63.3	12.2	0.0	0.0	49
N+1	31.7	41.5	24.4	2.4	2.4	41
N+2	24.2	54.5	21.2	0.0	2.4	33
N+3	28.0	44.0	28.0	0.0	2.4	25
N+4	22.7	45.5	31.8	0.0	2.4	22
N+5	21.1	47.4	31.6	0.0	2.4	19
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.5	10.3	83.8	4.4	4.4	68
N+1	5.6	22.2	63.0	9.3	13.3	54
N+2	5.3	21.1	68.4	5.3	17.8	38
N+3	11.8	23.5	64.7	0.0	17.8	34
N+4	20.0	28.0	52.0	0.0	17.8	25
N+5	23.1	15.4	53.8	7.7	24.1	13

TABLE 104.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.3	35.9	7.8	0.0	0.0	128
N+1	57.3	22.9	10.4	9.4	9.4	96
N+2	55.2	25.4	13.4	6.0	14.8	67
N+3	44.2	34.9	18.6	2.3	16.8	43
N+4	35.3	38.2	23.5	2.9	19.2	34
N+5	52.0	28.0	20.0	0.0	19.2	25
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.9	32.2	49.2	1.7	1.7	59
N+1	22.0	19.5	46.3	12.2	13.7	41
N+2	31.0	24.1	27.6	17.2	28.6	29
N+3	41.7	41.7	16.7	0.0	28.6	12
N+4	22.2	33.3	33.3	11.1	36.5	9
N+5	28.6	42.9	28.6	0.0	36.5	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.7	0.0	93.0	2.3	2.3	43
N+1	0.0	8.3	50.0	41.7	43.0	24
N+2	0.0	0.0	80.0	20.0	54.4	10
N+3	0.0	0.0	100.0	0.0	54.4	5
N+4	100.0	0.0	0.0	0.0	54.4	1
N+5	100.0	0.0	0.0	0.0	54.4	1

TABLE 105.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	45.2	25.8	22.6	6.5	6.5	31
N+1	38.1	23.8	23.8	14.3	19.8	21
N+2	53.3	6.7	26.7	13.3	30.5	15
N+3	50.0	16.7	33.3	0.0	30.5	6
N+4	0.0	33.3	66.7	0.0	30.5	3
N+5	100.0	0.0	0.0	0.0	30.5	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	16.7	50.0	16.7	16.7	6
N+1	0.0	33.3	33.3	33.3	44.4	3
N+2	0.0	0.0	100.0	0.0	44.4	2
N+3	0.0	0.0	100.0	0.0	44.4	1
N+4	0.0	0.0	0.0	0.0	44.4	0
N+5	0.0	0.0	0.0	0.0	44.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	22.2	55.6	22.2	22.2	9
N+1	0.0	0.0	40.0	60.0	68.9	5
N+2	0.0	0.0	100.0	0.0	68.9	1
N+3	0.0	0.0	100.0	0.0	68.9	1
N+4	0.0	0.0	0.0	0.0	68.9	0
N+5	0.0	0.0	0.0	0.0	68.9	0

TABLE 106.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	30.8	2.6	0.0	0.0	39
N+1	63.9	27.8	8.3	0.0	0.0	36
N+2	58.1	29.0	9.7	3.2	3.2	31
N+3	37.5	37.5	20.8	4.2	7.3	24
N+4	35.3	35.3	29.4	0.0	7.3	17
N+5	42.9	35.7	21.4	0.0	7.3	14
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.9	35.1	45.9	0.0	0.0	37
N+1	15.4	23.1	57.7	3.8	3.8	26
N+2	19.0	28.6	38.1	14.3	17.6	21
N+3	28.6	57.1	14.3	0.0	17.6	7
N+4	33.3	33.3	33.3	0.0	17.6	6
N+5	20.0	40.0	40.0	0.0	17.6	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	92.3	7.7	7.7	26
N+1	0.0	0.0	68.8	31.3	36.5	16
N+2	0.0	0.0	87.5	12.5	44.5	8
N+3	0.0	0.0	100.0	0.0	44.5	4
N+4	50.0	0.0	50.0	0.0	44.5	2
N+5	100.0	0.0	0.0	0.0	44.5	1

TABLE 107.

WHITE OAK * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	97.8	2.2	0.0	0.0	0.0	45
N+1	97.3	2.7	0.0	0.0	0.0	37
N+2	96.3	3.7	0.0	0.0	0.0	27
N+3	92.0	8.0	0.0	0.0	0.0	25
N+4	89.5	10.5	0.0	0.0	0.0	19
N+5	87.5	12.5	0.0	0.0	0.0	16
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	28.0	68.0	4.0	0.0	0.0	25
N+1	50.0	45.0	5.0	0.0	0.0	20
N+2	61.5	30.8	7.7	0.0	0.0	13
N+3	75.0	16.7	0.0	8.3	8.3	12
N+4	75.0	25.0	0.0	0.0	8.3	8
N+5	100.0	0.0	0.0	0.0	8.3	5
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	6.3	6.3	81.3	6.3	6.3	16
N+1	11.1	33.3	55.6	0.0	6.3	9
N+2	12.5	37.5	50.0	0.0	6.3	8
N+3	14.3	42.9	42.9	0.0	6.3	7
N+4	33.3	33.3	33.3	0.0	6.3	6
N+5	40.0	40.0	20.0	0.0	6.3	5

TABLE 108.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	50.2	34.5	15.3	0.0	0.0	235
N+1	40.8	33.5	14.6	11.2	11.2	206
N+2	36.3	37.0	21.2	5.5	16.0	146
N+3	27.3	30.3	34.8	7.6	22.4	66
N+4	25.5	32.7	36.4	5.5	26.6	55
N+5	30.8	23.1	43.6	2.6	28.5	39
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	20.7	35.1	43.3	1.0	1.0	208
N+1	15.6	26.6	40.3	17.5	18.3	154
N+2	23.4	21.3	42.6	12.8	28.8	94
N+3	14.3	12.5	64.3	8.9	35.1	56
N+4	13.2	15.8	68.4	2.6	36.8	38
N+5	3.4	24.1	69.0	3.4	39.0	29
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	1.7	7.3	90.2	0.9	0.9	234
N+1	2.3	4.7	59.9	33.1	33.7	172
N+2	4.9	8.6	71.6	14.8	43.5	81
N+3	2.2	4.4	84.4	8.9	48.6	45
N+4	2.9	8.6	80.0	8.6	53.0	35
N+5	4.0	12.0	84.0	0.0	53.0	25

TABLE 109.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	52.0	24.0	20.0	4.0	4.0	25
N+1	31.3	25.0	31.3	12.5	16.0	16
N+2	45.5	18.2	27.3	9.1	23.6	11
N+3	0.0	25.0	75.0	0.0	23.6	4
N+4	0.0	33.3	66.7	0.0	23.6	3
N+5	50.0	0.0	50.0	0.0	23.6	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	24.4	26.8	48.8	0.0	0.0	41
N+1	3.8	30.8	23.1	42.3	42.3	26
N+2	0.0	20.0	60.0	20.0	53.8	10
N+3	0.0	33.3	33.3	33.3	69.2	6
N+4	0.0	50.0	0.0	50.0	84.6	2
N+5	0.0	100.0	0.0	0.0	84.6	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.7	9.7	74.2	6.5	6.5	31
N+1	8.7	0.0	39.1	52.2	55.3	23
N+2	0.0	0.0	60.0	40.0	73.2	5
N+3	0.0	33.3	66.7	0.0	73.2	3
N+4	0.0	0.0	100.0	0.0	73.2	1
N+5	0.0	0.0	100.0	0.0	73.2	1

TABLE 110.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	54.7	30.2	15.1	0.0	0.0	86
N+1	35.5	46.1	17.1	1.3	1.3	76
N+2	35.8	37.3	25.4	1.5	2.8	67
N+3	38.2	32.4	23.5	5.9	8.5	34
N+4	34.6	30.8	34.6	0.0	8.5	26
N+5	33.3	28.6	38.1	0.0	8.5	21
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.1	42.7	46.1	1.1	1.1	89
N+1	18.1	25.0	48.6	8.3	9.4	72
N+2	19.0	22.4	46.6	12.1	20.3	58
N+3	15.2	21.2	63.6	0.0	20.3	33
N+4	11.1	18.5	70.4	0.0	20.3	27
N+5	5.3	26.3	68.4	0.0	20.3	19
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.5	93.7	1.8	1.8	111
N+1	3.3	3.3	75.0	18.5	19.9	92
N+2	3.3	4.9	82.0	9.8	27.8	61
N+3	2.8	0.0	91.7	5.6	31.8	36
N+4	0.0	7.1	82.1	10.7	39.1	28
N+5	0.0	14.3	85.7	0.0	39.1	21

TABLE III.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.0	13.3	20.0	6.7	6.7	15
N+1	20.0	40.0	30.0	10.0	16.0	10
N+2	42.9	42.9	14.3	0.0	16.0	7
N+3	0.0	0.0	100.0	0.0	16.0	1
N+4	0.0	0.0	100.0	0.0	16.0	1
N+5	0.0	0.0	100.0	0.0	16.0	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.1	40.9	45.5	4.5	4.5	22
N+1	0.0	28.6	28.6	42.9	45.5	14
N+2	0.0	20.0	40.0	40.0	67.3	5
N+3	0.0	100.0	0.0	0.0	67.3	1
N+4	0.0	0.0	0.0	0.0	67.3	0
N+5	0.0	0.0	0.0	0.0	67.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.3	87.5	6.3	6.3	16
N+1	0.0	0.0	61.5	38.5	42.3	13
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 112.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	87.9	8.6	3.4	0.0	0.0	58
N+1	89.6	4.2	6.3	0.0	0.0	48
N+2	85.7	14.3	0.0	0.0	0.0	42
N+3	82.9	14.3	2.9	0.0	0.0	35
N+4	90.0	10.0	0.0	0.0	0.0	20
N+5	84.2	15.8	0.0	0.0	0.0	19
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	17.6	64.7	16.2	1.5	1.5	68
N+1	23.1	63.5	11.5	1.9	3.4	52
N+2	20.9	60.5	18.6	0.0	3.4	43
N+3	22.5	50.0	27.5	0.0	3.4	40
N+4	27.8	50.0	19.4	2.8	6.0	36
N+5	25.9	48.1	25.9	0.0	6.0	27
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	2.3	6.8	88.6	2.3	2.3	132
N+1	2.5	14.4	76.3	6.8	8.9	118
N+2	2.3	21.8	73.6	2.3	11.0	87
N+3	6.8	19.2	74.0	0.0	11.0	73
N+4	10.7	17.9	67.9	3.6	14.2	56
N+5	10.3	20.5	69.2	0.0	14.2	39

TABLE 113.

WHITE OAK * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.0	36.0	8.0	0.0	0.0	25
N+1	52.6	36.8	0.0	10.5	10.5	19
N+2	58.3	33.3	0.0	8.3	18.0	12
N+3	0.0	71.4	28.6	0.0	18.0	7
N+4	28.6	57.1	14.3	0.0	18.0	7
N+5	25.0	50.0	25.0	0.0	18.0	4
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.7	39.3	50.0	0.0	0.0	28
N+1	11.1	16.7	50.0	22.2	22.2	18
N+2	0.0	55.6	44.4	0.0	22.2	9
N+3	0.0	66.7	33.3	0.0	22.2	3
N+4	0.0	50.0	50.0	0.0	22.2	2
N+5	0.0	50.0	50.0	0.0	22.2	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	9.1	90.9	0.0	0.0	11
N+1	0.0	0.0	71.4	28.6	28.6	7
N+2	0.0	0.0	100.0	0.0	28.6	4
N+3	0.0	33.3	66.7	0.0	28.6	3
N+4	0.0	33.3	66.7	0.0	28.6	3
N+5	0.0	0.0	100.0	0.0	28.6	2

TABLE 114.

GRAY BIRCH

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	81.5	14.0	3.8	0.7	0.7	1263
N+1	60.9	25.5	7.6	6.0	6.6	1125
N+2	62.0	21.7	8.3	8.0	14.1	626
N+3	40.4	40.7	12.4	6.5	19.7	275
N+4	40.1	40.6	13.9	5.4	24.1	202
N+5	42.2	40.3	13.6	3.9	27.0	154
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.7	58.0	20.5	0.7	0.7	405
N+1	22.2	46.3	21.2	10.3	11.0	311
N+2	14.1	48.8	18.2	18.8	27.7	170
N+3	2.7	58.0	31.3	8.0	33.5	112
N+4	13.2	36.8	44.1	5.9	37.4	68
N+5	11.9	40.7	40.7	6.8	41.7	59
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.7	7.1	89.4	0.9	0.9	113
N+1	3.0	4.5	74.6	17.9	18.6	67
N+2	0.0	4.8	71.4	23.8	38.0	21
N+3	0.0	9.1	90.9	0.0	38.0	11
N+4	0.0	28.6	71.4	0.0	38.0	7
N+5	0.0	33.3	66.7	0.0	38.0	6

TABLE 115.

GRAY BIRCH

DEFOLIATION HISTORY--HH

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	46.7	29.3	24.0	0.0	0.0	75
N+1	41.3	26.1	23.9	8.7	8.7	46
N+2	54.8	25.8	12.9	6.5	14.6	31
N+3	37.5	37.5	12.5	12.5	25.3	16
N+4	30.8	46.2	23.1	0.0	25.3	13
N+5	40.0	40.0	10.0	10.0	32.7	10
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	40.8	24.5	34.7	0.0	0.0	49
N+1	12.5	50.0	37.5	0.0	0.0	16
N+2	12.5	62.5	25.0	0.0	0.0	8
N+3	12.5	50.0	37.5	0.0	0.0	8
N+4	12.5	37.5	25.0	25.0	25.0	8
N+5	20.0	60.0	20.0	0.0	25.0	5
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	7.1	92.9	0.0	0.0	14
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 116.

GRAY BIRCH

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	40.0	20.0	40.0	0.0	0.0	10
N+1	40.0	40.0	0.0	20.0	20.0	5
N+2	0.0	0.0	0.0	0.0	20.0	0
N+3	0.0	0.0	0.0	0.0	20.0	0
N+4	0.0	0.0	0.0	0.0	20.0	0
N+5	0.0	0.0	0.0	0.0	20.0	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	31.8	40.9	9.1	9.1	22
N+1	0.0	66.7	33.3	0.0	9.1	12
N+2	0.0	75.0	25.0	0.0	9.1	4
N+3	50.0	0.0	50.0	0.0	9.1	2
N+4	0.0	0.0	0.0	0.0	9.1	0
N+5	0.0	0.0	0.0	0.0	9.1	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	62.5	12.5	12.5	8
N+1	0.0	33.3	66.7	0.0	12.5	3
N+2	0.0	0.0	100.0	0.0	12.5	1
N+3	0.0	0.0	0.0	0.0	12.5	0
N+4	0.0	0.0	0.0	0.0	12.5	0
N+5	0.0	0.0	0.0	0.0	12.5	0

TABLE 117.

GRAY BIRCH

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	77.7	16.9	5.3	0.1	0.1	676
N+1	45.0	38.9	10.3	5.8	6.0	565
N+2	51.4	28.1	12.6	7.9	13.4	356
N+3	29.6	50.4	15.2	4.8	17.5	125
N+4	19.3	59.0	19.3	2.4	19.5	83
N+5	20.6	55.9	22.1	1.5	20.7	68
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.9	65.2	19.9	1.0	1.0	201
N+1	11.4	51.7	25.5	11.4	12.3	149
N+2	7.2	42.0	20.3	30.4	39.0	69
N+3	6.1	51.5	33.3	9.1	44.5	33
N+4	4.8	33.3	52.4	9.5	49.8	21
N+5	0.0	33.3	61.1	5.6	52.6	18
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.4	96.6	0.0	0.0	58
N+1	2.4	0.0	87.8	9.8	9.8	41
N+2	0.0	0.0	73.7	26.3	33.5	19
N+3	0.0	0.0	100.0	0.0	33.5	6
N+4	0.0	33.3	66.7	0.0	33.5	6
N+5	0.0	40.0	60.0	0.0	33.5	5

TABLE 118.

GRAY BIRCH

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	63.4	23.0	11.3	2.3	2.3	391
N+1	41.4	38.6	9.7	10.3	12.4	350
N+2	35.3	40.8	11.9	11.9	22.8	201
N+3	16.8	53.5	24.8	5.0	26.6	101
N+4	30.4	39.3	25.0	5.4	30.6	56
N+5	32.7	42.3	21.2	3.8	33.2	52
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	47.5	30.0	2.5	2.5	40
N+1	10.3	51.7	37.9	0.0	2.5	29
N+2	7.7	53.8	38.5	0.0	2.5	13
N+3	8.3	58.3	33.3	0.0	2.5	12
N+4	0.0	62.5	37.5	0.0	2.5	8
N+5	0.0	62.5	37.5	0.0	2.5	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	12.5	87.5	0.0	0.0	16
N+1	0.0	10.0	80.0	10.0	10.0	10
N+2	0.0	0.0	100.0	0.0	10.0	4
N+3	0.0	0.0	100.0	0.0	10.0	4
N+4	0.0	0.0	100.0	0.0	10.0	1
N+5	0.0	0.0	100.0	0.0	10.0	1

TABLE 119.

GRAY BIRCH

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	47.8	27.2	20.7	4.3	4.3	92
N+1	37.1	29.0	29.0	4.8	9.0	62
N+2	42.6	34.0	19.1	4.3	12.8	47
N+3	37.5	37.5	12.5	12.5	23.7	16
N+4	30.8	46.2	23.1	0.0	23.7	13
N+5	40.0	40.0	10.0	10.0	31.4	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	45.5	13.6	40.9	0.0	0.0	22
N+1	18.2	36.4	45.5	0.0	0.0	11
N+2	11.1	66.7	22.2	0.0	0.0	9
N+3	12.5	50.0	37.5	0.0	0.0	8
N+4	12.5	37.5	25.0	25.0	25.0	8
N+5	20.0	60.0	20.0	0.0	25.0	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	6
N+1	0.0	0.0	100.0	0.0	0.0	4
N+2	0.0	25.0	75.0	0.0	0.0	4
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 120.

GRAY BIRCH

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	88.7	6.7	3.9	0.7	0.7	284
N+1	78.8	13.0	3.9	4.3	5.0	231
N+2	68.1	12.8	10.6	8.5	13.1	47
N+3	69.7	18.2	12.1	0.0	13.1	33
N+4	70.8	20.8	8.3	0.0	13.1	24
N+5	57.1	21.4	14.3	7.1	19.3	14
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	24.2	61.5	9.3	4.9	4.9	182
N+1	28.8	47.1	22.9	1.3	6.2	153
N+2	26.9	42.3	24.4	6.4	12.2	78
N+3	31.6	35.1	29.8	3.5	15.3	57
N+4	29.3	36.6	34.1	0.0	15.3	41
N+5	54.5	33.3	12.1	0.0	15.3	33
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	9.7	9.7	74.2	6.5	6.5	93
N+1	9.4	20.3	65.6	4.7	10.8	64
N+2	7.1	28.6	60.7	3.6	14.0	28
N+3	6.7	46.7	46.7	0.0	14.0	15
N+4	20.0	40.0	40.0	0.0	14.0	5
N+5	50.0	0.0	50.0	0.0	14.0	2

TABLE 121.

GRAY BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.9	11.0	2.8	0.3	0.3	580
N+1	63.0	25.8	7.4	3.9	4.2	516
N+2	68.6	17.7	6.0	7.8	11.7	283
N+3	45.9	34.2	13.5	6.3	17.2	111
N+4	50.0	36.7	8.9	4.4	20.9	90
N+5	49.4	36.4	10.4	3.9	24.0	77
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	22.2	58.8	19.1	0.0	0.0	194
N+1	17.9	51.7	22.5	7.9	7.9	151
N+2	5.9	55.3	23.5	15.3	22.0	85
N+3	1.5	61.5	29.2	7.7	28.0	65
N+4	10.9	43.5	43.5	2.2	29.6	46
N+5	9.1	45.5	38.6	6.8	34.4	44
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.1	5.1	87.2	2.6	2.6	39
N+1	0.0	15.0	70.0	15.0	17.2	20
N+2	0.0	0.0	100.0	0.0	17.2	4
N+3	0.0	0.0	100.0	0.0	17.2	4
N+4	0.0	0.0	100.0	0.0	17.2	2
N+5	0.0	0.0	100.0	0.0	17.2	1

TABLE 122.

GRAY BIRCH * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.5	25.6	12.8	0.0	0.0	39
N+1	47.8	34.8	13.0	4.3	4.3	23
N+2	61.1	16.7	11.1	11.1	15.0	18
N+3	60.0	20.0	10.0	10.0	23.5	10
N+4	44.4	33.3	22.2	0.0	23.5	9
N+5	57.1	28.6	14.3	0.0	23.5	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	48.0	20.0	32.0	0.0	0.0	25
N+1	16.7	50.0	33.3	0.0	0.0	6
N+2	33.3	0.0	66.7	0.0	0.0	3
N+3	33.3	0.0	66.7	0.0	0.0	3
N+4	33.3	0.0	33.3	33.3	33.3	3
N+5	50.0	0.0	50.0	0.0	33.3	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	33.3	66.7	0.0	0.0	3
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 123.

GRAY BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	82.3	14.1	3.5	0.0	0.0	311
N+1	48.3	37.5	9.7	4.5	4.5	267
N+2	59.2	24.3	9.2	7.2	11.4	152
N+3	41.5	43.9	12.2	2.4	13.6	41
N+4	32.1	53.6	10.7	3.6	16.7	28
N+5	34.8	52.2	13.0	0.0	16.7	23
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.7	66.3	18.0	0.0	0.0	89
N+1	9.1	54.5	25.8	10.6	10.6	66
N+2	3.8	42.3	30.8	23.1	31.2	26
N+3	7.1	57.1	28.6	7.1	36.1	14
N+4	9.1	27.3	63.6	0.0	36.1	11
N+5	0.0	20.0	70.0	10.0	42.5	10
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	19
N+1	0.0	0.0	90.9	9.1	9.1	11
N+2	0.0	0.0	100.0	0.0	9.1	1
N+3	0.0	0.0	100.0	0.0	9.1	1
N+4	0.0	0.0	100.0	0.0	9.1	1
N+5	0.0	0.0	0.0	0.0	9.1	0

TABLE 124.

GRAY BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.4	28.6	9.9	1.0	1.0	192
N+1	41.2	44.1	7.9	6.8	7.8	177
N+2	29.1	48.5	9.7	12.6	19.4	103
N+3	14.1	57.8	23.4	4.7	23.2	64
N+4	29.5	47.7	18.2	4.5	26.7	44
N+5	31.0	50.0	16.7	2.4	28.4	42
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	45.8	37.5	0.0	0.0	24
N+1	11.1	44.4	44.4	0.0	0.0	18
N+2	0.0	60.0	40.0	0.0	0.0	10
N+3	0.0	66.7	33.3	0.0	0.0	9
N+4	0.0	62.5	37.5	0.0	0.0	8
N+5	0.0	62.5	37.5	0.0	0.0	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	14.3	85.7	0.0	0.0	7
N+1	0.0	16.7	83.3	0.0	0.0	6
N+2	0.0	0.0	100.0	0.0	0.0	3
N+3	0.0	0.0	100.0	0.0	0.0	3
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 125.

GRAY BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	59.5	24.3	16.2	0.0	0.0	37
N+1	47.8	26.1	21.7	4.3	4.3	23
N+2	61.1	11.1	16.7	11.1	15.0	18
N+3	60.0	20.0	10.0	10.0	23.5	10
N+4	44.4	33.3	22.2	0.0	23.5	9
N+5	57.1	28.6	14.3	0.0	23.5	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	45.5	9.1	45.5	0.0	0.0	11
N+1	33.3	0.0	66.7	0.0	0.0	3
N+2	33.3	0.0	66.7	0.0	0.0	3
N+3	33.3	0.0	66.7	0.0	0.0	3
N+4	33.3	0.0	33.3	33.3	33.3	3
N+5	50.0	0.0	50.0	0.0	33.3	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 126.

GRAY BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	87.7	8.2	4.1	0.0	0.0	122
N+1	80.6	10.2	3.1	6.1	6.1	98
N+2	60.0	20.0	20.0	0.0	6.1	20
N+3	52.9	23.5	23.5	0.0	6.1	17
N+4	57.1	28.6	14.3	0.0	6.1	14
N+5	44.4	33.3	22.2	0.0	6.1	9
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	18.2	64.9	10.4	6.5	6.5	77
N+1	25.4	52.4	20.6	1.6	8.0	63
N+2	28.6	46.4	25.0	0.0	8.0	28
N+3	38.9	33.3	27.8	0.0	8.0	18
N+4	41.7	33.3	25.0	0.0	8.0	12
N+5	60.0	10.0	30.0	0.0	8.0	10
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	8.3	8.3	75.0	8.3	8.3	36
N+1	8.3	33.3	54.2	4.2	12.2	24
N+2	8.3	25.0	66.7	0.0	12.2	12
N+3	0.0	42.9	57.1	0.0	12.2	7
N+4	0.0	66.7	33.3	0.0	12.2	3
N+5	100.0	0.0	0.0	0.0	12.2	1

TABLE 127.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.0	15.7	4.1	1.1	1.1	610
N+1	58.9	25.8	8.0	7.3	8.4	547
N+2	56.9	25.5	9.7	7.9	15.6	318
N+3	35.5	46.7	11.8	5.9	20.6	152
N+4	29.9	44.9	18.7	6.5	25.8	107
N+5	30.6	47.2	18.1	4.2	28.9	72
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.2	56.4	21.2	1.1	1.1	179
N+1	25.9	43.2	19.4	11.5	12.5	139
N+2	21.3	44.0	13.3	21.3	31.2	75
N+3	2.5	50.0	37.5	10.0	38.0	40
N+4	20.0	20.0	45.0	15.0	47.3	20
N+5	23.1	23.1	46.2	7.7	51.4	13
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.2	8.7	89.1	0.0	0.0	46
N+1	6.3	0.0	71.9	21.9	21.9	32
N+2	0.0	8.3	58.3	33.3	47.9	12
N+3	0.0	20.0	80.0	0.0	47.9	5
N+4	0.0	66.7	33.3	0.0	47.9	3
N+5	0.0	66.7	33.3	0.0	47.9	3

TABLE 128.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	34.5	27.6	37.9	0.0	0.0	29
N+1	38.9	22.2	27.8	11.1	11.1	18
N+2	45.5	36.4	18.2	0.0	11.1	11
N+3	0.0	66.7	16.7	16.7	25.9	6
N+4	0.0	75.0	25.0	0.0	25.9	4
N+5	0.0	66.7	0.0	33.3	50.6	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.4	27.8	27.8	0.0	0.0	18
N+1	12.5	50.0	37.5	0.0	0.0	8
N+2	0.0	100.0	0.0	0.0	0.0	5
N+3	0.0	80.0	20.0	0.0	0.0	5
N+4	0.0	60.0	20.0	20.0	20.0	5
N+5	0.0	100.0	0.0	0.0	20.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 129.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	75.1	18.4	6.2	0.3	0.3	337
N+1	41.8	40.7	11.3	6.2	6.5	275
N+2	45.9	32.0	14.4	7.7	13.7	194
N+3	22.2	55.6	17.3	4.9	18.0	81
N+4	11.1	63.0	24.1	1.9	19.5	54
N+5	11.4	59.1	27.3	2.3	21.3	44
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.6	63.6	21.6	1.1	1.1	88
N+1	14.1	46.9	28.1	10.9	11.9	64
N+2	5.3	42.1	15.8	36.8	44.4	38
N+3	0.0	40.0	46.7	13.3	51.8	15
N+4	0.0	33.3	44.4	22.2	62.5	9
N+5	0.0	42.9	57.1	0.0	62.5	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.7	96.3	0.0	0.0	27
N+1	5.0	0.0	85.0	10.0	10.0	20
N+2	0.0	0.0	69.2	30.8	37.7	13
N+3	0.0	0.0	100.0	0.0	37.7	3
N+4	0.0	66.7	33.3	0.0	37.7	3
N+5	0.0	66.7	33.3	0.0	37.7	3

TABLE 130.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.5	17.8	13.2	3.4	3.4	174
N+1	41.3	32.9	11.6	14.2	17.2	155
N+2	44.8	33.3	12.6	9.2	24.8	87
N+3	21.9	46.9	28.1	3.1	27.1	32
N+4	36.4	9.1	45.5	9.1	33.7	11
N+5	44.4	11.1	33.3	11.1	41.1	9
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	23.1	46.2	23.1	7.7	7.7	13
N+1	0.0	75.0	25.0	0.0	7.7	8
N+2	0.0	50.0	50.0	0.0	7.7	2
N+3	0.0	50.0	50.0	0.0	7.7	2
N+4	0.0	0.0	0.0	0.0	7.7	0
N+5	0.0	0.0	0.0	0.0	7.7	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	80.0	0.0	0.0	5
N+1	0.0	0.0	66.7	33.3	33.3	3
N+2	0.0	0.0	100.0	0.0	33.3	1
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	0.0	0.0	33.3	0
N+5	0.0	0.0	0.0	0.0	33.3	0

TABLE 131.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	42.6	27.7	23.4	6.4	6.4	47
N+1	31.4	34.3	28.6	5.7	11.7	35
N+2	29.6	48.1	22.2	0.0	11.7	27
N+3	0.0	66.7	16.7	16.7	26.4	6
N+4	0.0	75.0	25.0	0.0	26.4	4
N+5	0.0	66.7	0.0	33.3	51.0	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.0	10.0	40.0	0.0	0.0	10
N+1	14.3	42.9	42.9	0.0	0.0	7
N+2	0.0	100.0	0.0	0.0	0.0	6
N+3	0.0	80.0	20.0	0.0	0.0	5
N+4	0.0	60.0	20.0	20.0	20.0	5
N+5	0.0	100.0	0.0	0.0	20.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 132.

GRAY BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	90.6	5.8	2.2	1.4	1.4	138
N+1	77.9	15.9	3.5	2.7	4.1	113
N+2	64.7	11.8	5.9	17.6	21.0	17
N+3	87.5	12.5	0.0	0.0	21.0	8
N+4	100.0	0.0	0.0	0.0	21.0	5
N+5	50.0	0.0	0.0	50.0	60.5	2
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	29.3	58.7	8.7	3.3	3.3	92
N+1	32.5	41.2	25.0	1.2	4.5	80
N+2	25.5	42.6	25.5	6.4	10.6	47
N+3	26.3	36.8	31.6	5.3	15.3	38
N+4	21.4	39.3	39.3	0.0	15.3	28
N+5	50.0	45.5	4.5	0.0	15.3	22
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	11.8	11.8	70.6	5.9	5.9	51
N+1	10.8	13.5	70.3	5.4	11.0	37
N+2	6.3	31.3	56.3	6.3	16.5	16
N+3	12.5	50.0	37.5	0.0	16.5	8
N+4	50.0	0.0	50.0	0.0	16.5	2
N+5	0.0	0.0	100.0	0.0	16.5	1

TABLE 133.

GRAY BIRCH * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.0	30.9	9.1	0.0	0.0	55
N+1	63.6	18.2	6.8	11.4	11.4	44
N+2	45.0	25.0	20.0	10.0	20.2	20
N+3	50.0	20.0	10.0	20.0	36.2	10
N+4	80.0	20.0	0.0	0.0	36.2	5
N+5	100.0	0.0	0.0	0.0	36.2	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	66.7	26.7	6.7	6.7	15
N+1	8.3	25.0	33.3	33.3	37.8	12
N+2	20.0	40.0	0.0	40.0	62.7	5
N+3	33.3	66.7	0.0	0.0	62.7	3
N+4	0.0	100.0	0.0	0.0	62.7	1
N+5	0.0	100.0	0.0	0.0	62.7	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.3	93.8	0.0	0.0	16
N+1	0.0	0.0	88.9	11.1	11.1	9
N+2	0.0	0.0	66.7	33.3	40.7	3
N+3	0.0	0.0	100.0	0.0	40.7	1
N+4	0.0	0.0	100.0	0.0	40.7	1
N+5	0.0	0.0	100.0	0.0	40.7	1

TABLE 134.

GRAY BIRCH * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	55.0	30.0	15.0	0.0	0.0	20
N+1	40.0	33.3	6.7	20.0	20.0	15
N+2	33.3	11.1	33.3	22.2	37.8	9
N+3	66.7	0.0	0.0	33.3	58.5	3
N+4	100.0	0.0	0.0	0.0	58.5	1
N+5	100.0	0.0	0.0	0.0	58.5	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	64.3	28.6	7.1	7.1	14
N+1	9.1	36.4	27.3	27.3	32.5	11
N+2	25.0	50.0	0.0	25.0	49.4	4
N+3	33.3	66.7	0.0	0.0	49.4	3
N+4	0.0	100.0	0.0	0.0	49.4	1
N+5	0.0	100.0	0.0	0.0	49.4	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	11.1	88.9	0.0	0.0	9
N+1	0.0	0.0	87.5	12.5	12.5	8
N+2	0.0	0.0	75.0	25.0	34.4	4
N+3	0.0	0.0	100.0	0.0	34.4	1
N+4	0.0	0.0	100.0	0.0	34.4	1
N+5	0.0	0.0	100.0	0.0	34.4	1

TABLE 135.

GRAY BIRCH * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	81.8	4.5	13.6	0.0	0.0	22
N+1	75.0	10.0	10.0	5.0	5.0	20
N+2	90.0	0.0	0.0	10.0	14.5	10
N+3	87.5	12.5	0.0	0.0	14.5	8
N+4	80.0	20.0	0.0	0.0	14.5	5
N+5	100.0	0.0	0.0	0.0	14.5	3
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	23.1	61.5	7.7	7.7	7.7	13
N+1	20.0	60.0	20.0	0.0	7.7	10
N+2	33.3	0.0	0.0	66.7	69.2	3
N+3	100.0	0.0	0.0	0.0	69.2	1
N+4	100.0	0.0	0.0	0.0	69.2	1
N+5	100.0	0.0	0.0	0.0	69.2	1
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 136.

PAPER BIRCH

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	95.5	2.8	1.7	0.0	0.0	179
N+1	90.2	6.1	2.5	1.2	1.2	163
N+2	87.4	7.9	2.4	2.4	3.6	127
N+3	86.9	8.2	4.9	0.0	3.6	61
N+4	88.3	6.7	3.3	1.7	5.2	60
N+5	87.7	8.8	3.5	0.0	5.2	57
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	77.8	22.2	0.0	0.0	9
N+1	0.0	62.5	25.0	12.5	12.5	8
N+2	0.0	40.0	40.0	20.0	30.0	5
N+3	0.0	100.0	0.0	0.0	30.0	1
N+4	0.0	100.0	0.0	0.0	30.0	1
N+5	0.0	0.0	0.0	0.0	30.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.5	0.0	87.5	0.0	0.0	8
N+1	25.0	0.0	50.0	25.0	25.0	4
N+2	100.0	0.0	0.0	0.0	25.0	1
N+3	0.0	0.0	100.0	0.0	25.0	1
N+4	0.0	0.0	100.0	0.0	25.0	1
N+5	0.0	0.0	100.0	0.0	25.0	1

TABLE 137.

PAPER BIRCH

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	94.9	2.9	2.3	0.0	0.0	175
N+1	90.3	5.8	2.6	1.3	1.3	154
N+2	89.7	5.6	2.8	1.9	3.1	107
N+3	96.1	2.0	2.0	0.0	3.1	51
N+4	91.2	8.8	0.0	0.0	3.1	34
N+5	93.9	6.1	0.0	0.0	3.1	33
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	60.0	40.0	0.0	0.0	10
N+1	0.0	37.5	50.0	12.5	12.5	8
N+2	0.0	40.0	40.0	20.0	30.0	5
N+3	0.0	100.0	0.0	0.0	30.0	1
N+4	0.0	100.0	0.0	0.0	30.0	1
N+5	0.0	0.0	0.0	0.0	30.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.3	0.0	85.7	0.0	0.0	7
N+1	33.3	0.0	33.3	33.3	33.3	3
N+2	100.0	0.0	0.0	0.0	33.3	1
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	100.0	0.0	33.3	1
N+5	0.0	0.0	100.0	0.0	33.3	1

TABLE 138.

PAPER BIRCH

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	96.1	2.7	0.6	0.6	0.6	337
N+1	94.5	2.9	1.1	1.5	2.1	272
N+2	88.4	10.7	0.9	0.0	2.1	215
N+3	84.7	14.9	0.5	0.0	2.1	202
N+4	85.9	12.5	1.1	0.5	2.6	184
N+5	81.5	16.3	2.2	0.0	2.6	178
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	12.8	85.1	2.1	0.0	0.0	47
N+1	22.0	70.7	4.9	2.4	2.4	41
N+2	32.4	56.8	10.8	0.0	2.4	37
N+3	34.3	54.3	11.4	0.0	2.4	35
N+4	29.0	54.8	16.1	0.0	2.4	31
N+5	27.6	62.1	10.3	0.0	2.4	29
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	21.4	14.3	64.3	0.0	0.0	14
N+1	27.3	9.1	36.4	27.3	27.3	11
N+2	40.0	0.0	60.0	0.0	27.3	5
N+3	25.0	0.0	75.0	0.0	27.3	4
N+4	0.0	0.0	100.0	0.0	27.3	2
N+5	0.0	0.0	100.0	0.0	27.3	2

TABLE 139.

PAPER BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	97.6	2.4	0.0	0.0	0.0	85
N+1	91.0	7.7	1.3	0.0	0.0	78
N+2	90.0	8.3	0.0	1.7	1.7	60
N+3	88.5	7.7	3.8	0.0	1.7	26
N+4	84.6	7.7	7.7	0.0	1.7	26
N+5	84.6	7.7	7.7	0.0	1.7	26
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	3
N+1	0.0	100.0	0.0	0.0	0.0	3
N+2	0.0	66.7	33.3	0.0	0.0	3
N+3	0.0	100.0	0.0	0.0	0.0	1
N+4	0.0	100.0	0.0	0.0	0.0	1
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 140.

PAPER BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	98.7	1.3	0.0	0.0	0.0	78
N+1	92.8	7.2	0.0	0.0	0.0	69
N+2	93.2	6.8	0.0	0.0	0.0	44
N+3	100.0	0.0	0.0	0.0	0.0	15
N+4	93.3	6.7	0.0	0.0	0.0	15
N+5	93.3	6.7	0.0	0.0	0.0	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	2
N+1	0.0	100.0	0.0	0.0	0.0	2
N+2	0.0	100.0	0.0	0.0	0.0	2
N+3	0.0	100.0	0.0	0.0	0.0	1
N+4	0.0	100.0	0.0	0.0	0.0	1
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 141.

PAPER BIRCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	97.6	2.4	0.0	0.0	0.0	84
N+1	98.4	1.6	0.0	0.0	0.0	61
N+2	92.1	7.9	0.0	0.0	0.0	38
N+3	86.8	13.2	0.0	0.0	0.0	38
N+4	88.6	11.4	0.0	0.0	0.0	35
N+5	81.3	12.5	6.3	0.0	0.0	32
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	6
N+1	20.0	80.0	0.0	0.0	0.0	5
N+2	20.0	40.0	40.0	0.0	0.0	5
N+3	20.0	40.0	40.0	0.0	0.0	5
N+4	0.0	50.0	50.0	0.0	0.0	4
N+5	0.0	50.0	50.0	0.0	0.0	4
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	75.0	25.0	25.0	4
N+2	0.0	0.0	100.0	0.0	25.0	3
N+3	0.0	0.0	100.0	0.0	25.0	2
N+4	0.0	0.0	100.0	0.0	25.0	2
N+5	0.0	0.0	100.0	0.0	25.0	2

TABLE 142.

PAPER BIRCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	23
N+1	95.5	4.5	0.0	0.0	0.0	22
N+2	94.1	5.9	0.0	0.0	0.0	17
N+3	100.0	0.0	0.0	0.0	0.0	12
N+4	100.0	0.0	0.0	0.0	0.0	12
N+5	100.0	0.0	0.0	0.0	0.0	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 143.

PAPER BIRCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	95.8	0.0	4.2	0.0	0.0	24
N+1	90.9	4.5	4.5	0.0	0.0	22
N+2	93.8	6.3	0.0	0.0	0.0	16
N+3	100.0	0.0	0.0	0.0	0.0	12
N+4	100.0	0.0	0.0	0.0	0.0	7
N+5	100.0	0.0	0.0	0.0	0.0	6
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 144.

PAPER BIRCH * DCMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	97.3	0.9	0.9	0.9	0.9	111
N+1	97.8	1.1	0.0	1.1	2.0	92
N+2	96.2	3.8	0.0	0.0	2.0	79
N+3	94.7	5.3	0.0	0.0	2.0	75
N+4	94.1	4.4	1.5	0.0	2.0	68
N+5	91.0	7.5	1.5	0.0	2.0	67
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	5
N+1	0.0	100.0	0.0	0.0	0.0	4
N+2	0.0	100.0	0.0	0.0	0.0	4
N+3	0.0	100.0	0.0	0.0	0.0	4
N+4	25.0	75.0	0.0	0.0	0.0	4
N+5	25.0	75.0	0.0	0.0	0.0	4
POCR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	33.3	0.0	66.7	0.0	0.0	3
N+1	33.3	0.0	0.0	66.7	66.7	3
N+2	100.0	0.0	0.0	0.0	66.7	1
N+3	0.0	0.0	100.0	0.0	66.7	1
N+4	0.0	0.0	0.0	0.0	66.7	C
N+5	0.0	0.0	0.0	0.0	66.7	C

TABLE 145.

PAPER BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	92.2	4.7	3.1	0.0	0.0	64
N+1	89.3	5.4	5.4	0.0	0.0	56
N+2	80.0	8.9	6.7	4.4	4.4	45
N+3	77.3	13.6	9.1	0.0	4.4	22
N+4	85.7	9.5	0.0	4.8	9.0	21
N+5	85.0	15.0	0.0	0.0	9.0	20
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	66.7	33.3	0.0	0.0	6
N+1	0.0	40.0	40.0	20.0	20.0	5
N+2	0.0	0.0	50.0	50.0	60.0	2
N+3	0.0	0.0	0.0	0.0	60.0	0
N+4	0.0	0.0	0.0	0.0	60.0	0
N+5	0.0	0.0	0.0	0.0	60.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	0.0	83.3	0.0	0.0	6
N+1	25.0	0.0	50.0	25.0	25.0	4
N+2	100.0	0.0	0.0	0.0	25.0	1
N+3	0.0	0.0	100.0	0.0	25.0	1
N+4	0.0	0.0	100.0	0.0	25.0	1
N+5	0.0	0.0	100.0	0.0	25.0	1

TABLE 146.

PAPER BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	91.8	4.9	3.3	0.0	0.0	61
N+1	90.2	3.9	5.9	0.0	0.0	51
N+2	82.1	5.1	7.7	5.1	5.1	39
N+3	88.9	5.6	5.6	0.0	5.1	18
N+4	81.8	18.2	0.0	0.0	5.1	11
N+5	90.9	9.1	0.0	0.0	5.1	11
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	57.1	42.9	0.0	0.0	7
N+1	0.0	16.7	66.7	16.7	16.7	6
N+2	0.0	0.0	66.7	33.3	44.4	3
N+3	0.0	0.0	0.0	0.0	44.4	0
N+4	0.0	0.0	0.0	0.0	44.4	0
N+5	0.0	0.0	0.0	0.0	44.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	0.0	80.0	0.0	0.0	5
N+1	33.3	0.0	33.3	33.3	33.3	3
N+2	100.0	0.0	0.0	0.0	33.3	1
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	100.0	0.0	33.3	1
N+5	0.0	0.0	100.0	0.0	33.3	1

TABLE 147.

PAPER BIRCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.3	4.9	0.8	0.0	0.0	123
N+1	89.2	4.9	2.9	2.9	2.9	102
N+2	80.2	17.4	2.3	0.0	2.9	86
N+3	74.4	24.4	1.3	0.0	2.9	78
N+4	76.1	21.1	1.4	1.4	4.3	71
N+5	71.0	27.5	1.4	0.0	4.3	69
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	13.3	86.7	0.0	0.0	0.0	30
N+1	22.2	70.4	7.4	0.0	0.0	27
N+2	33.3	58.3	8.3	0.0	0.0	24
N+3	36.4	54.5	9.1	0.0	0.0	22
N+4	30.0	55.0	15.0	0.0	0.0	20
N+5	22.2	72.2	5.6	0.0	0.0	18
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	28.6	28.6	42.9	0.0	0.0	7
N+1	50.0	25.0	25.0	0.0	0.0	4
N+2	100.0	0.0	0.0	0.0	0.0	1
N+3	100.0	0.0	0.0	0.0	0.0	1
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 148.

RIVER BIRCH

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	73.9	21.7	4.3	0.0	0.0	115
N+1	73.2	19.6	4.1	3.1	3.1	97
N+2	60.0	26.7	8.9	4.4	7.4	45
N+3	10.0	26.7	63.3	0.0	7.4	30
N+4	6.7	30.0	63.3	0.0	7.4	30
N+5	3.7	33.3	63.0	0.0	7.4	27
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.7	71.4	14.3	3.6	3.6	28
N+1	44.4	44.4	5.6	5.6	8.9	18
N+2	0.0	50.0	25.0	25.0	31.7	4
N+3	0.0	50.0	50.0	0.0	31.7	2
N+4	0.0	50.0	50.0	0.0	31.7	2
N+5	0.0	100.0	0.0	0.0	31.7	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	16.7	66.7	16.7	16.7	6
N+1	25.0	0.0	25.0	50.0	58.3	4
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 149.

RIVER BIRCH

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.2	30.6	6.1	2.0	2.0	49
N+1	72.7	22.7	4.5	0.0	2.0	22
N+2	59.1	27.3	9.1	4.5	6.5	22
N+3	10.5	26.3	63.2	0.0	6.5	19
N+4	5.3	31.6	63.2	0.0	6.5	19
N+5	5.6	27.8	66.7	0.0	6.5	18
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	41.7	50.0	8.3	0.0	0.0	12
N+1	27.3	54.5	9.1	9.1	9.1	11
N+2	22.2	55.6	11.1	11.1	19.2	9
N+3	0.0	37.5	62.5	0.0	19.2	8
N+4	0.0	37.5	62.5	0.0	19.2	8
N+5	0.0	50.0	50.0	0.0	19.2	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	1
N+1	0.0	100.0	0.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 150.

RIVER BIRCH

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	4
N+1	100.0	0.0	0.0	0.0	0.0	4
N+2	100.0	0.0	0.0	0.0	0.0	4
N+3	100.0	0.0	0.0	0.0	0.0	4
N+4	100.0	0.0	0.0	0.0	0.0	4
N+5	100.0	0.0	0.0	0.0	0.0	1
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	5.3	94.7	0.0	0.0	0.0	19
N+1	31.6	52.6	15.8	0.0	0.0	19
N+2	31.6	52.6	15.8	0.0	0.0	19
N+3	42.1	42.1	15.8	0.0	0.0	19
N+4	55.6	27.8	16.7	0.0	0.0	18
N+5	44.4	22.2	33.3	0.0	0.0	9
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	3.4	96.6	0.0	0.0	29
N+1	0.0	20.8	79.2	0.0	0.0	24
N+2	0.0	25.0	70.8	4.2	4.2	24
N+3	0.0	47.8	52.2	0.0	4.2	23
N+4	8.7	43.5	47.8	0.0	4.2	23
N+5	15.4	30.8	53.8	0.0	4.2	13

TABLE 151.

RIVER BIRCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	81.1	17.0	1.9	0.0	0.0	53
N+1	86.7	8.9	4.4	0.0	0.0	45
N+2	75.0	12.5	4.2	8.3	8.3	24
N+3	6.7	33.3	60.0	0.0	8.3	15
N+4	6.7	33.3	60.0	0.0	8.3	15
N+5	0.0	42.9	57.1	0.0	8.3	14
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	83.3	0.0	0.0	0.0	6
N+1	50.0	50.0	0.0	0.0	0.0	4
N+2	0.0	100.0	0.0	0.0	0.0	1
N+3	0.0	100.0	0.0	0.0	0.0	1
N+4	0.0	100.0	0.0	0.0	0.0	1
N+5	0.0	100.0	0.0	0.0	0.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	C
N+1	0.0	0.0	0.0	0.0	0.0	C
N+2	0.0	0.0	0.0	0.0	0.0	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 152.

RIVER BIRCH * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	71.4	28.6	0.0	0.0	0.0	21
N+1	83.3	8.3	8.3	0.0	0.0	12
N+2	75.0	16.7	0.0	8.3	8.3	12
N+3	0.0	40.0	60.0	0.0	8.3	1C
N+4	0.0	40.0	60.0	0.0	8.3	1C
N+5	0.0	40.0	60.0	0.0	8.3	1C
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	33.3	66.7	0.0	0.0	0.0	3
N+1	0.0	100.0	0.0	0.0	0.0	2
N+2	0.0	100.0	0.0	0.0	0.0	2
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	50.0	50.0	0.0	0.0	2
N+5	0.0	50.0	50.0	0.0	0.0	2
PCOR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	C
N+1	0.0	0.0	0.0	0.0	0.0	C
N+2	0.0	0.0	0.0	0.0	0.0	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 153.

RIVER BIRCH * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	71.7	26.4	1.9	0.0	0.0	53
N+1	65.9	29.5	2.3	2.3	2.3	44
N+2	42.1	47.4	10.5	0.0	2.3	19
N+3	7.7	23.1	69.2	0.0	2.3	13
N+4	7.7	23.1	69.2	0.0	2.3	13
N+5	8.3	25.0	66.7	0.0	2.3	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.5	78.9	10.5	0.0	0.0	19
N+1	46.2	46.2	7.7	0.0	0.0	13
N+2	0.0	33.3	33.3	33.3	33.3	3
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	100.0	0.0	33.3	1
N+5	0.0	0.0	0.0	0.0	33.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 154.

RIVER BIRCH * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	54.2	37.5	8.3	0.0	0.0	24
N+1	55.6	44.4	0.0	0.0	0.0	9
N+2	33.3	44.4	22.2	0.0	0.0	9
N+3	12.5	12.5	75.0	0.0	0.0	8
N+4	12.5	12.5	75.0	0.0	0.0	8
N+5	12.5	12.5	75.0	0.0	0.0	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.4	44.4	11.1	0.0	0.0	9
N+1	33.3	44.4	11.1	11.1	11.1	9
N+2	28.6	42.9	14.3	14.3	23.8	7
N+3	0.0	33.3	66.7	0.0	23.8	6
N+4	0.0	33.3	66.7	0.0	23.8	6
N+5	0.0	50.0	50.0	0.0	23.8	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 155.

ASPEN

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.3	8.6	4.9	1.2	1.2	407
N+1	74.9	8.6	3.9	12.5	13.6	383
N+2	66.2	14.1	4.7	15.0	26.5	234
N+3	71.1	17.8	4.6	6.6	31.4	152
N+4	69.8	11.9	4.0	14.3	41.2	126
N+5	76.2	19.0	4.8	0.0	41.2	21
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.9	58.8	25.5	9.8	9.8	51
N+1	27.8	8.3	8.3	55.6	59.9	36
N+2	26.7	13.3	6.7	53.3	81.3	15
N+3	0.0	40.0	60.0	0.0	81.3	5
N+4	0.0	0.0	33.3	66.7	93.8	3
N+5	0.0	0.0	0.0	0.0	93.8	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.2	8.3	79.2	8.3	8.3	24
N+1	0.0	7.7	23.1	69.2	71.8	13
N+2	0.0	0.0	33.3	66.7	90.6	3
N+3	0.0	0.0	0.0	0.0	90.6	0
N+4	0.0	0.0	0.0	0.0	90.6	0
N+5	0.0	0.0	0.0	0.0	90.6	0

TABLE 156.

ASPEN

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	53.1	21.9	21.9	3.1	3.1	64
N+1	48.2	12.5	3.6	35.7	37.7	56
N+2	61.3	25.8	0.0	12.9	45.8	31
N+3	40.0	46.7	6.7	6.7	49.4	15
N+4	50.0	30.0	10.0	10.0	54.4	10
N+5	50.0	37.5	12.5	0.0	54.4	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.0	60.0	30.0	0.0	0.0	30
N+1	43.5	8.7	8.7	39.1	39.1	23
N+2	30.8	15.4	7.7	46.2	67.2	13
N+3	0.0	40.0	60.0	0.0	67.2	5
N+4	0.0	0.0	33.3	66.7	89.1	3
N+5	0.0	0.0	0.0	0.0	89.1	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.9	11.8	70.6	11.8	11.8	17
N+1	0.0	0.0	42.9	57.1	62.2	7
N+2	0.0	0.0	50.0	50.0	81.1	2
N+3	0.0	0.0	0.0	0.0	81.1	0
N+4	0.0	0.0	0.0	0.0	81.1	0
N+5	0.0	0.0	0.0	0.0	81.1	0

TABLE 157.

ASPEN

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	54.8	22.6	6.5	16.1	16.1	31
N+1	50.0	25.0	0.0	25.0	37.1	12
N+2	88.9	0.0	0.0	11.1	44.1	9
N+3	87.5	12.5	0.0	0.0	44.1	8
N+4	0.0	0.0	0.0	100.0	100.0	2
N+5	0.0	0.0	0.0	0.0	100.0	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 158.

ASPEN

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.9	3.0	0.0	3.0	3.0	33
N+1	65.0	5.0	25.0	5.0	7.9	20
N+2	58.8	5.9	23.5	11.8	18.7	17
N+3	58.3	8.3	33.3	0.0	18.7	12
N+4	85.7	0.0	14.3	0.0	18.7	7
N+5	100.0	0.0	0.0	0.0	18.7	4
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	52.2	34.8	8.7	4.3	4.3	23
N+1	25.0	20.0	20.0	35.0	37.8	20
N+2	30.0	10.0	20.0	40.0	62.7	10
N+3	20.0	20.0	40.0	20.0	70.2	5
N+4	100.0	0.0	0.0	0.0	70.2	1
N+5	0.0	0.0	0.0	0.0	70.2	0
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	6.7	13.3	66.7	13.3	13.3	15
N+1	20.0	20.0	20.0	40.0	48.0	5
N+2	0.0	50.0	50.0	0.0	48.0	2
N+3	0.0	50.0	50.0	0.0	48.0	2
N+4	0.0	0.0	100.0	0.0	48.0	1
N+5	0.0	0.0	0.0	0.0	48.0	0

TABLE 159.

ASPEN * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	87.6	9.5	2.9	0.0	0.0	137
N+1	84.1	6.1	3.8	6.1	6.1	132
N+2	82.7	6.1	4.1	7.1	12.8	98
N+3	87.5	9.7	0.0	2.8	15.2	72
N+4	84.4	6.3	1.6	7.8	21.8	64
N+5	70.0	30.0	0.0	0.0	21.8	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	50.0	33.3	8.3	8.3	12
N+1	0.0	9.1	18.2	72.7	75.0	11
N+2	0.0	33.3	0.0	66.7	91.7	3
N+3	0.0	100.0	0.0	0.0	91.7	1
N+4	0.0	0.0	100.0	0.0	91.7	1
N+5	0.0	0.0	0.0	0.0	91.7	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	9.1	81.8	9.1	9.1	11
N+1	0.0	20.0	20.0	60.0	63.6	5
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 160.

ASPEN * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.2	21.7	8.7	4.3	4.3	23
N+1	50.0	13.6	9.1	27.3	30.4	22
N+2	90.9	9.1	0.0	0.0	30.4	11
N+3	80.0	20.0	0.0	0.0	30.4	5
N+4	75.0	25.0	0.0	0.0	30.4	4
N+5	50.0	50.0	0.0	0.0	30.4	4
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	20.0	60.0	0.0	0.0	5
N+1	0.0	0.0	20.0	80.0	80.0	5
N+2	0.0	100.0	0.0	0.0	80.0	1
N+3	0.0	100.0	0.0	0.0	80.0	1
N+4	0.0	0.0	100.0	0.0	80.0	1
N+5	0.0	0.0	0.0	0.0	80.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	75.0	25.0	25.0	8
N+1	0.0	0.0	0.0	100.0	100.0	2
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 161.

ASPEN * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.3	14.9	9.5	1.4	1.4	74
N+1	73.2	9.9	4.2	12.7	13.9	71
N+2	50.0	9.1	4.5	36.4	45.2	22
N+3	14.3	42.9	28.6	14.3	53.0	7
N+4	20.0	20.0	20.0	40.0	71.8	5
N+5	50.0	0.0	50.0	0.0	71.8	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	58.3	20.8	12.5	12.5	24
N+1	50.0	6.3	0.0	43.8	50.8	16
N+2	44.4	0.0	0.0	55.6	78.1	9
N+3	0.0	33.3	66.7	0.0	78.1	3
N+4	0.0	0.0	0.0	100.0	100.0	2
N+5	0.0	0.0	0.0	0.0	100.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	66.7	33.3	33.3	3
N+1	0.0	0.0	50.0	50.0	66.7	2
N+2	0.0	0.0	100.0	0.0	66.7	1
N+3	0.0	0.0	0.0	0.0	66.7	0
N+4	0.0	0.0	0.0	0.0	66.7	0
N+5	0.0	0.0	0.0	0.0	66.7	0

TABLE 162.

ASPEN * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	89.8	4.8	4.2	1.2	1.2	166
N+1	72.0	10.8	3.8	13.4	14.4	157
N+2	55.2	21.9	4.8	18.1	29.9	105
N+3	59.4	24.6	7.2	8.7	36.0	69
N+4	56.4	18.2	5.5	20.0	48.8	55
N+5	85.7	14.3	0.0	0.0	48.8	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	66.7	25.0	8.3	8.3	12
N+1	28.6	0.0	14.3	57.1	60.7	7
N+2	0.0	0.0	50.0	50.0	80.4	2
N+3	0.0	0.0	100.0	0.0	80.4	1
N+4	0.0	0.0	0.0	0.0	80.4	0
N+5	0.0	0.0	0.0	0.0	80.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	0.0	80.0	0.0	0.0	5
N+1	0.0	0.0	0.0	100.0	100.0	2
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 163.

ASPEN * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	77.3	9.1	4.5	9.1	9.1	22
N+1	50.0	0.0	6.3	43.8	48.9	16
N+2	66.7	16.7	16.7	0.0	48.9	6
N+3	100.0	0.0	0.0	0.0	48.9	3
N+4	100.0	0.0	0.0	0.0	48.9	2
N+5	100.0	0.0	0.0	0.0	48.9	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	80.0	0.0	0.0	5
N+1	0.0	0.0	25.0	75.0	75.0	4
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 164.

WILLOW

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	41.7	50.0	8.3	0.0	0.0	60
N+1	24.0	50.0	26.0	0.0	0.0	50
N+2	27.3	45.5	27.3	0.0	0.0	33
N+3	38.5	30.8	30.8	0.0	0.0	13
N+4	37.5	62.5	0.0	0.0	0.0	8
N+5	25.0	75.0	0.0	0.0	0.0	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.9	44.8	48.3	0.0	0.0	87
N+1	13.6	15.3	66.1	5.1	5.1	59
N+2	23.1	23.1	53.8	0.0	5.1	39
N+3	29.2	12.5	58.3	0.0	5.1	24
N+4	16.7	16.7	66.7	0.0	5.1	18
N+5	16.7	16.7	66.7	0.0	5.1	18
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	8.0	91.4	0.6	0.6	175
N+1	0.0	5.2	82.8	12.1	12.6	116
N+2	0.0	2.5	97.5	0.0	12.6	79
N+3	0.0	1.9	98.1	0.0	12.6	52
N+4	0.0	16.7	83.3	0.0	12.6	48
N+5	0.0	17.0	83.0	0.0	12.6	47

TABLE 165.

WILLOW

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	70.0	30.0	0.0	0.0	10
N+1	0.0	0.0	80.0	20.0	20.0	5
N+2	0.0	0.0	100.0	0.0	20.0	1
N+3	0.0	0.0	100.0	0.0	20.0	1
N+4	0.0	100.0	0.0	0.0	20.0	1
N+5	0.0	100.0	0.0	0.0	20.0	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	3.7	25.9	70.4	0.0	0.0	27
N+1	0.0	35.0	55.0	10.0	10.0	20
N+2	0.0	43.8	56.3	0.0	10.0	16
N+3	0.0	30.0	70.0	0.0	10.0	10
N+4	0.0	37.5	62.5	0.0	10.0	8
N+5	0.0	37.5	62.5	0.0	10.0	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	5.8	94.2	0.0	0.0	52
N+1	2.2	6.5	78.3	13.0	13.0	46
N+2	2.6	0.0	97.4	0.0	13.0	39
N+3	3.8	0.0	96.2	0.0	13.0	26
N+4	0.0	21.7	78.3	0.0	13.0	23
N+5	0.0	21.7	78.3	0.0	13.0	23

TABLE 166.

WILLOW

DEFOLIATION HISTORY--LLH

YEAR	GOCC	FAIR	PCOR	CEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	46.2	53.8	0.0	0.0	0.0	13
N+1	41.7	41.7	16.7	0.0	0.0	12
N+2	45.5	45.5	9.1	0.0	0.0	11
N+3	50.0	40.0	10.0	0.0	0.0	10
N+4	33.3	66.7	0.0	0.0	0.0	6
N+5	33.3	66.7	0.0	0.0	0.0	6
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	19.0	33.3	47.6	0.0	0.0	21
N+1	43.8	12.5	43.8	0.0	0.0	16
N+2	50.0	12.5	37.5	0.0	0.0	16
N+3	54.5	0.0	45.5	0.0	0.0	11
N+4	42.9	14.3	42.9	0.0	0.0	7
N+5	42.9	14.3	42.9	0.0	0.0	7
PCOR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	4.6	95.4	0.0	0.0	65
N+1	0.0	6.3	93.8	0.0	0.0	32
N+2	0.0	10.5	89.5	0.0	0.0	19
N+3	0.0	16.7	83.3	0.0	0.0	6
N+4	0.0	50.0	50.0	0.0	0.0	4
N+5	0.0	50.0	50.0	0.0	0.0	4

TABLE 167.

WILLOW

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	5
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	100.0	0.0	0.0	0.0	1
N+5	0.0	100.0	0.0	0.0	0.0	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	41.7	50.0	0.0	0.0	12
N+1	0.0	54.5	45.5	0.0	0.0	11
N+2	0.0	45.5	54.5	0.0	0.0	11
N+3	0.0	50.0	50.0	0.0	0.0	6
N+4	0.0	75.0	25.0	0.0	0.0	4
N+5	0.0	75.0	25.0	0.0	0.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.3	95.7	0.0	0.0	46
N+1	2.3	7.0	81.4	9.3	9.3	43
N+2	2.6	0.0	97.4	0.0	9.3	38
N+3	4.0	0.0	96.0	0.0	9.3	25
N+4	0.0	22.7	77.3	0.0	9.3	22
N+5	0.0	22.7	77.3	0.0	9.3	22

TABLE 168.

WILLOW

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.3	7.7	0.0	0.0	0.0	13
N+1	83.3	8.3	8.3	0.0	0.0	12
N+2	83.3	8.3	8.3	0.0	0.0	12
N+3	83.3	0.0	16.7	0.0	0.0	12
N+4	77.8	11.1	11.1	0.0	0.0	9
N+5	77.8	11.1	11.1	0.0	0.0	9
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	4.3	76.1	19.6	0.0	0.0	46
N+1	18.6	65.1	16.3	0.0	0.0	43
N+2	16.3	65.1	18.6	0.0	0.0	43
N+3	16.7	59.5	23.8	0.0	0.0	42
N+4	22.2	50.0	27.8	0.0	0.0	36
N+5	33.3	50.0	16.7	0.0	0.0	30
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	2.9	97.1	0.0	0.0	104
N+1	1.1	17.2	81.7	0.0	0.0	93
N+2	1.2	28.7	70.0	0.0	0.0	80
N+3	4.3	28.6	67.1	0.0	0.0	70
N+4	7.9	30.2	61.9	0.0	0.0	63
N+5	8.9	44.6	44.6	1.8	1.8	56

TABLE 169.

LINDEN

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	95.7	4.3	0.0	0.0	0.0	70
N+1	80.6	13.4	6.0	0.0	0.0	67
N+2	58.7	15.9	25.4	0.0	0.0	63
N+3	55.3	21.1	23.7	0.0	0.0	38
N+4	60.0	4.0	36.0	0.0	0.0	25
N+5	45.8	12.5	41.7	0.0	0.0	24
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	75.0	5.0	0.0	0.0	20
N+1	23.1	76.9	0.0	0.0	0.0	13
N+2	23.1	69.2	7.7	0.0	0.0	13
N+3	0.0	80.0	20.0	0.0	0.0	5
N+4	0.0	80.0	20.0	0.0	0.0	5
N+5	0.0	80.0	20.0	0.0	0.0	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	9
N+1	0.0	25.0	50.0	25.0	25.0	4
N+2	0.0	33.3	66.7	0.0	25.0	3
N+3	0.0	0.0	100.0	0.0	25.0	1
N+4	0.0	0.0	100.0	0.0	25.0	1
N+5	0.0	0.0	100.0	0.0	25.0	1

TABLE 170.

LINDEN

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	38
N+1	88.6	2.9	8.6	0.0	0.0	35
N+2	58.1	3.2	38.7	0.0	0.0	31
N+3	37.5	6.3	56.3	0.0	0.0	16
N+4	37.5	6.3	56.3	0.0	0.0	16
N+5	26.7	13.3	60.0	0.0	0.0	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	75.0	5.0	0.0	0.0	20
N+1	23.1	76.9	0.0	0.0	0.0	13
N+2	23.1	69.2	7.7	0.0	0.0	13
N+3	0.0	80.0	20.0	0.0	0.0	5
N+4	0.0	80.0	20.0	0.0	0.0	5
N+5	0.0	80.0	20.0	0.0	0.0	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	7
N+1	0.0	50.0	50.0	0.0	0.0	2
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 171.

LINDEN

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.3	5.8	1.9	0.0	0.0	52
N+1	92.0	4.0	2.0	2.0	2.0	50
N+2	91.7	6.3	2.1	0.0	2.0	48
N+3	95.7	2.2	2.2	0.0	2.0	46
N+4	94.9	2.6	0.0	2.6	4.5	39
N+5	90.9	9.1	0.0	0.0	4.5	33
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	38.5	53.8	7.7	0.0	0.0	13
N+1	46.2	46.2	7.7	0.0	0.0	13
N+2	46.2	38.5	15.4	0.0	0.0	13
N+3	55.6	22.2	22.2	0.0	0.0	9
N+4	66.7	22.2	11.1	0.0	0.0	9
N+5	62.5	25.0	12.5	0.0	0.0	8
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	15.0	85.0	0.0	0.0	20
N+1	0.0	25.0	68.8	6.3	6.3	16
N+2	0.0	35.7	64.3	0.0	6.3	14
N+3	0.0	55.6	44.4	0.0	6.3	9
N+4	0.0	66.7	33.3	0.0	6.3	6
N+5	0.0	50.0	50.0	0.0	6.3	4

TABLE 172.

LARCH

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	98.6	1.4	0.0	0.0	0.0	147
N+1	96.6	2.7	0.0	0.7	0.7	146
N+2	79.6	13.1	6.6	0.7	1.4	137
N+3	73.6	18.4	8.0	0.0	1.4	87
N+4	72.6	20.2	6.0	1.2	2.6	84
N+5	74.1	13.6	11.1	1.2	3.8	81
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	87.5	6.3	6.3	0.0	0.0	16
N+1	93.3	6.7	0.0	0.0	0.0	15
N+2	66.7	26.7	6.7	0.0	0.0	15
N+3	33.3	50.0	0.0	16.7	16.7	6
N+4	40.0	60.0	0.0	0.0	16.7	5
N+5	40.0	0.0	60.0	0.0	16.7	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	2
N+1	50.0	0.0	0.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 173.

LARCH

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	97.3	2.7	0.0	0.0	0.0	149
N+1	96.6	2.7	0.0	0.7	0.7	146
N+2	79.6	13.1	6.6	0.7	1.4	137
N+3	73.6	18.4	8.0	0.0	1.4	87
N+4	72.6	20.2	6.0	1.2	2.6	84
N+5	74.1	13.6	11.1	1.2	3.8	81
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	87.5	6.3	6.3	0.0	0.0	16
N+1	93.3	6.7	0.0	0.0	0.0	15
N+2	66.7	26.7	6.7	0.0	0.0	15
N+3	33.3	50.0	0.0	16.7	16.7	6
N+4	40.0	60.0	0.0	0.0	16.7	5
N+5	40.0	0.0	60.0	0.0	16.7	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	0.0	33.3	0.0	0.0	3
N+1	33.3	33.3	0.0	33.3	33.3	3
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 174.

LARCH

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	89.8	5.6	3.6	1.0	1.0	196
N+1	89.4	5.7	4.1	0.8	1.8	123
N+2	62.5	14.2	23.3	0.0	1.8	120
N+3	61.9	15.3	22.9	0.0	1.8	118
N+4	53.1	20.8	26.0	0.0	1.8	96
N+5	31.5	32.6	35.9	0.0	1.8	92
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	29.3	51.2	17.1	2.4	2.4	41
N+1	31.6	55.3	13.2	0.0	2.4	38
N+2	52.8	22.2	25.0	0.0	2.4	36
N+3	60.0	14.3	25.7	0.0	2.4	35
N+4	57.1	9.5	33.3	0.0	2.4	21
N+5	68.4	15.8	15.8	0.0	2.4	19
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	4.2	8.3	81.3	6.3	6.3	48
N+1	4.9	9.8	80.5	4.9	10.8	41
N+2	31.4	57.1	11.4	0.0	10.8	35
N+3	31.4	57.1	8.6	2.9	13.4	35
N+4	50.0	0.0	50.0	0.0	13.4	4
N+5	50.0	50.0	0.0	0.0	13.4	4

TABLE 175.

LARCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	20
N+1	100.0	0.0	0.0	0.0	0.0	20
N+2	77.8	11.1	11.1	0.0	0.0	18
N+3	70.0	10.0	20.0	0.0	0.0	10
N+4	70.0	10.0	20.0	0.0	0.0	10
N+5	50.0	10.0	40.0	0.0	0.0	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 176.

LARCH * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	20
N+1	100.0	0.0	0.0	0.0	0.0	20
N+2	77.8	11.1	11.1	0.0	0.0	18
N+3	70.0	10.0	20.0	0.0	0.0	10
N+4	70.0	10.0	20.0	0.0	0.0	10
N+5	50.0	10.0	40.0	0.0	0.0	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 177.

LARCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	75
N+1	97.3	1.3	0.0	1.3	1.3	75
N+2	79.2	13.9	6.9	0.0	1.3	72
N+3	74.0	18.0	8.0	0.0	1.3	50
N+4	77.1	18.8	4.2	0.0	1.3	48
N+5	87.0	10.9	2.2	0.0	1.3	46
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	33.3	0.0	0.0	0.0	3
N+1	66.7	33.3	0.0	0.0	0.0	3
N+2	66.7	33.3	0.0	0.0	0.0	3
N+3	66.7	33.3	0.0	0.0	0.0	3
N+4	66.7	33.3	0.0	0.0	0.0	3
N+5	66.7	0.0	33.3	0.0	0.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 178.

LARCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	75
N+1	97.3	1.3	0.0	1.3	1.3	75
N+2	79.2	13.9	6.9	0.0	1.3	72
N+3	74.0	18.0	8.0	0.0	1.3	50
N+4	77.1	18.8	4.2	0.0	1.3	48
N+5	87.0	10.9	2.2	0.0	1.3	46
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	33.3	0.0	0.0	0.0	3
N+1	66.7	33.3	0.0	0.0	0.0	3
N+2	66.7	33.3	0.0	0.0	0.0	3
N+3	66.7	33.3	0.0	0.0	0.0	3
N+4	66.7	33.3	0.0	0.0	0.0	3
N+5	66.7	0.0	33.3	0.0	0.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 179.

LARCH * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.2	5.1	1.7	0.0	0.0	118
N+1	92.6	4.9	2.5	0.0	0.0	81
N+2	62.5	15.0	22.5	0.0	0.0	80
N+3	62.0	15.2	22.8	0.0	0.0	79
N+4	53.1	20.3	26.6	0.0	0.0	64
N+5	34.4	29.5	36.1	0.0	0.0	61
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	43.5	43.5	13.0	0.0	0.0	23
N+1	43.5	47.8	8.7	0.0	0.0	23
N+2	69.6	13.0	17.4	0.0	0.0	23
N+3	78.3	4.3	17.4	0.0	0.0	23
N+4	71.4	0.0	28.6	0.0	0.0	14
N+5	84.6	15.4	0.0	0.0	0.0	13
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	7.7	11.5	80.8	0.0	0.0	26
N+1	7.7	11.5	76.9	3.8	3.8	26
N+2	47.8	47.8	4.3	0.0	3.8	23
N+3	47.8	47.8	4.3	0.0	3.8	23
N+4	66.7	0.0	33.3	0.0	3.8	3
N+5	66.7	33.3	0.0	0.0	3.8	3

TABLE 180.

LARCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	95.2	4.8	0.0	0.0	0.0	42
N+1	92.7	7.3	0.0	0.0	0.0	41
N+2	78.4	16.2	2.7	2.7	2.7	37
N+3	66.7	28.6	4.8	0.0	2.7	21
N+4	55.0	35.0	5.0	5.0	7.6	20
N+5	47.4	26.3	21.1	5.3	12.4	19
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	88.9	0.0	11.1	0.0	0.0	9
N+1	100.0	0.0	0.0	0.0	0.0	8
N+2	50.0	37.5	12.5	0.0	0.0	8
N+3	0.0	66.7	0.0	33.3	33.3	3
N+4	0.0	100.0	0.0	0.0	33.3	2
N+5	0.0	0.0	100.0	0.0	33.3	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	2
N+1	50.0	0.0	0.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 181.

LARCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	90.9	9.1	0.0	0.0	0.0	44
N+1	92.7	7.3	0.0	0.0	0.0	41
N+2	78.4	16.2	2.7	2.7	2.7	37
N+3	66.7	28.6	4.8	0.0	2.7	21
N+4	55.0	35.0	5.0	5.0	7.6	20
N+5	47.4	26.3	21.1	5.3	12.4	19
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	88.9	0.0	11.1	0.0	0.0	9
N+1	100.0	0.0	0.0	0.0	0.0	8
N+2	50.0	37.5	12.5	0.0	0.0	8
N+3	0.0	66.7	0.0	33.3	33.3	3
N+4	0.0	100.0	0.0	0.0	33.3	2
N+5	0.0	0.0	100.0	0.0	33.3	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	2
N+1	50.0	0.0	0.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 182.

LARCH * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	80.0	8.9	6.7	4.4	4.4	45
N+1	78.9	10.5	10.5	0.0	4.4	19
N+2	61.1	11.1	27.8	0.0	4.4	18
N+3	61.1	16.7	22.2	0.0	4.4	18
N+4	53.3	26.7	20.0	0.0	4.4	15
N+5	35.7	28.6	35.7	0.0	4.4	14
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	7.1	57.1	28.6	7.1	7.1	14
N+1	9.1	63.6	27.3	0.0	7.1	11
N+2	22.2	33.3	44.4	0.0	7.1	9
N+3	25.0	25.0	50.0	0.0	7.1	8
N+4	20.0	40.0	40.0	0.0	7.1	5
N+5	25.0	0.0	75.0	0.0	7.1	4
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	8.3	75.0	16.7	16.7	12
N+1	0.0	16.7	83.3	0.0	16.7	6
N+2	0.0	75.0	25.0	0.0	16.7	4
N+3	0.0	75.0	25.0	0.0	16.7	4
N+4	0.0	0.0	0.0	0.0	16.7	0
N+5	0.0	0.0	0.0	0.0	16.7	0

TABLE 183.

RED MAPLE

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	57.6	33.1	9.0	0.3	0.3	290
N+1	61.2	24.7	9.0	5.1	5.4	178
N+2	64.5	20.6	9.9	5.0	10.1	141
N+3	66.2	17.3	13.5	3.0	12.8	133
N+4	61.0	24.4	12.2	2.4	14.9	123
N+5	57.0	26.3	14.0	2.6	17.2	114
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.0	40.7	43.6	0.7	0.7	140
N+1	10.6	31.8	30.3	27.3	27.8	66
N+2	17.5	32.5	42.5	7.5	33.2	40
N+3	14.7	32.4	44.1	8.8	39.1	34
N+4	13.3	36.7	50.0	0.0	39.1	30
N+5	27.6	20.7	51.7	0.0	39.1	29
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.6	94.5	1.8	1.8	55
N+1	2.8	0.0	52.8	44.4	45.5	36
N+2	0.0	5.3	84.2	10.5	51.2	19
N+3	0.0	6.3	68.8	25.0	63.4	16
N+4	0.0	0.0	90.0	10.0	67.1	10
N+5	0.0	0.0	100.0	0.0	67.1	9

TABLE 184.

RED MAPLE

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	33.0	47.4	18.6	1.0	1.0	97
N+1	62.5	21.9	9.4	6.3	7.2	64
N+2	61.0	20.3	13.6	5.1	11.9	59
N+3	64.3	16.1	17.9	1.8	13.5	56
N+4	50.9	29.1	16.4	3.6	16.7	55
N+5	45.1	31.4	19.6	3.9	19.9	51
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	3.1	23.4	70.3	3.1	3.1	64
N+1	3.1	18.8	25.0	53.1	54.6	32
N+2	16.7	16.7	58.3	8.3	58.4	12
N+3	18.2	9.1	45.5	27.3	69.7	11
N+4	0.0	42.9	57.1	0.0	69.7	7
N+5	0.0	28.6	71.4	0.0	69.7	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	12
N+1	0.0	0.0	100.0	0.0	0.0	5
N+2	0.0	0.0	100.0	0.0	0.0	5
N+3	0.0	0.0	100.0	0.0	0.0	4
N+4	0.0	0.0	100.0	0.0	0.0	4
N+5	0.0	0.0	100.0	0.0	0.0	4

TABLE 185.

RED MAPLE

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	34.6	23.1	38.5	3.8	3.8	26
N+1	20.0	13.3	46.7	20.0	23.1	15
N+2	22.2	22.2	44.4	11.1	31.6	9
N+3	50.0	0.0	0.0	50.0	65.8	4
N+4	100.0	0.0	0.0	0.0	65.8	1
N+5	100.0	0.0	0.0	0.0	65.8	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.4	11.5	69.2	3.8	3.8	26
N+1	5.9	11.8	41.2	41.2	43.4	17
N+2	10.0	0.0	90.0	0.0	43.4	10
N+3	0.0	12.5	75.0	12.5	50.5	8
N+4	0.0	0.0	85.7	14.3	57.6	7
N+5	0.0	0.0	100.0	0.0	57.6	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	66.7	33.3	33.3	3
N+1	0.0	0.0	0.0	0.0	33.3	0
N+2	0.0	0.0	0.0	0.0	33.3	0
N+3	0.0	0.0	0.0	0.0	33.3	0
N+4	0.0	0.0	0.0	0.0	33.3	0
N+5	0.0	0.0	0.0	0.0	33.3	0

TABLE 186.

RED MAPLE

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	69.7	22.6	7.7	0.0	0.0	208
N+1	59.3	22.1	13.3	5.3	5.3	113
N+2	63.5	17.7	14.6	4.2	9.3	96
N+3	67.4	15.7	12.4	4.5	13.3	89
N+4	65.2	18.2	13.6	3.0	16.0	66
N+5	61.1	22.2	14.8	1.9	17.5	54
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.7	45.3	44.0	0.0	0.0	75
N+1	14.3	35.7	31.0	19.0	19.0	42
N+2	4.3	43.5	43.5	8.7	26.1	23
N+3	0.0	38.9	55.6	5.6	30.2	18
N+4	0.0	41.2	58.8	0.0	30.2	17
N+5	26.7	13.3	60.0	0.0	30.2	15
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	83.3	16.7	16.7	24
N+1	0.0	0.0	69.2	30.8	42.3	13
N+2	0.0	0.0	75.0	25.0	56.7	8
N+3	0.0	16.7	50.0	33.3	71.2	6
N+4	0.0	0.0	100.0	0.0	71.2	3
N+5	0.0	0.0	100.0	0.0	71.2	3

TABLE 187.

RED MAPLE

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
	GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION					
N	30.4	47.8	13.0	8.7	8.7	23
N+1	50.0	0.0	50.0	0.0	8.7	2
N+2	100.0	0.0	0.0	0.0	8.7	1
N+3	100.0	0.0	0.0	0.0	8.7	1
N+4	100.0	0.0	0.0	0.0	8.7	1
N+5	100.0	0.0	0.0	0.0	8.7	1
	FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION					
N	20.0	0.0	60.0	20.0	20.0	5
N+1	0.0	0.0	50.0	50.0	60.0	2
N+2	0.0	0.0	100.0	0.0	60.0	1
N+3	0.0	0.0	100.0	0.0	60.0	1
N+4	0.0	0.0	0.0	0.0	60.0	0
N+5	0.0	0.0	0.0	0.0	60.0	0
	POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION					
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 188.

RED MAPLE

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	28.4	52.6	14.7	4.2	4.2	95
N+1	73.3	17.3	5.3	4.0	8.0	75
N+2	69.8	17.5	9.5	3.2	11.0	63
N+3	68.9	14.8	16.4	0.0	11.0	61
N+4	52.1	33.3	12.5	2.1	12.8	48
N+5	46.8	34.0	14.9	4.3	16.5	47
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	26.1	58.7	15.2	15.2	46
N+1	5.6	27.8	22.2	44.4	52.9	18
N+2	22.2	22.2	44.4	11.1	58.1	9
N+3	25.0	12.5	50.0	12.5	63.4	8
N+4	0.0	50.0	50.0	0.0	63.4	6
N+5	0.0	33.3	66.7	0.0	63.4	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	83.3	16.7	16.7	6
N+1	0.0	0.0	100.0	0.0	16.7	3
N+2	0.0	0.0	100.0	0.0	16.7	3
N+3	0.0	0.0	100.0	0.0	16.7	2
N+4	0.0	0.0	100.0	0.0	16.7	1
N+5	0.0	0.0	100.0	0.0	16.7	1

TABLE 189.

RED MAPLE

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.5	5.9	1.6	0.1	0.1	1539
N+1	88.1	9.5	2.3	0.1	0.1	1421
N+2	80.9	13.1	5.7	0.3	0.4	1331
N+3	77.9	13.2	8.5	0.4	0.8	1229
N+4	75.3	15.0	9.4	0.3	1.2	1183
N+5	71.1	16.3	12.3	0.3	1.5	1062
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	18.4	71.7	9.0	0.9	0.9	700
N+1	23.6	60.6	13.9	1.9	2.8	627
N+2	26.0	52.1	20.7	1.2	3.9	576
N+3	27.4	49.3	21.6	1.7	5.6	515
N+4	29.0	47.3	21.6	2.1	7.6	486
N+5	33.5	40.9	23.9	1.7	9.2	406
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.3	6.5	85.8	6.3	6.3	459
N+1	1.8	12.2	79.7	6.2	12.2	385
N+2	2.7	18.7	71.1	7.5	18.8	332
N+3	5.2	19.2	74.2	1.5	20.0	271
N+4	6.6	25.9	64.6	2.9	22.3	243
N+5	7.3	31.4	55.0	6.3	27.2	191

TABLE 190.

RED MAPLE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	58.1	37.2	4.7	0.0	0.0	43
N+1	60.0	12.0	16.0	12.0	12.0	25
N+2	77.8	5.6	16.7	0.0	12.0	18
N+3	77.8	11.1	5.6	5.6	16.9	18
N+4	58.8	29.4	11.8	0.0	16.9	17
N+5	58.8	23.5	17.6	0.0	16.9	17
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.4	28.6	50.0	0.0	0.0	14
N+1	12.5	25.0	12.5	50.0	50.0	8
N+2	50.0	25.0	0.0	25.0	62.5	4
N+3	66.7	0.0	33.3	0.0	62.5	3
N+4	66.7	0.0	33.3	0.0	62.5	3
N+5	66.7	0.0	33.3	0.0	62.5	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	5
N+1	0.0	0.0	66.7	33.3	33.3	3
N+2	0.0	0.0	100.0	0.0	33.3	2
N+3	0.0	0.0	100.0	0.0	33.3	2
N+4	0.0	0.0	100.0	0.0	33.3	2
N+5	0.0	0.0	100.0	0.0	33.3	2

TABLE 191.

RED MAPLE * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.7	11.4	2.9	0.0	0.0	35
N+1	66.7	0.0	20.0	13.3	13.3	15
N+2	69.2	0.0	30.8	0.0	13.3	13
N+3	69.2	15.4	7.7	7.7	20.0	13
N+4	66.7	22.2	11.1	0.0	20.0	9
N+5	71.4	0.0	28.6	0.0	20.0	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	5
N+1	0.0	20.0	20.0	60.0	60.0	5
N+2	0.0	50.0	0.0	50.0	80.0	2
N+3	0.0	0.0	100.0	0.0	80.0	1
N+4	0.0	0.0	100.0	0.0	80.0	1
N+5	0.0	0.0	100.0	0.0	80.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 192.

RED MAPLE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	77.3	4.5	0.0	0.0	22
N+1	88.9	5.6	5.6	0.0	0.0	18
N+2	83.3	16.7	0.0	0.0	0.0	18
N+3	77.8	11.1	11.1	0.0	0.0	18
N+4	54.5	36.4	9.1	0.0	0.0	11
N+5	54.5	36.4	9.1	0.0	0.0	11
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	33.3	66.7	0.0	0.0	3
N+1	0.0	0.0	0.0	0.0	0.0	C
N+2	0.0	0.0	0.0	0.0	0.0	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 193.

RED MAPLE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.2	3.8	3.1	0.0	0.0	293
N+1	89.0	6.2	4.8	0.0	0.0	273
N+2	80.6	11.9	7.5	0.0	0.0	252
N+3	72.9	12.7	14.4	0.0	0.0	236
N+4	72.4	10.8	16.8	0.0	0.0	232
N+5	65.6	13.7	20.8	0.0	0.0	212
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	18.8	59.4	21.9	0.0	0.0	64
N+1	25.8	40.3	30.6	3.2	3.2	62
N+2	22.2	35.2	42.6	0.0	3.2	54
N+3	20.4	26.5	53.1	0.0	3.2	49
N+4	19.1	25.5	46.8	8.5	11.5	47
N+5	20.6	29.4	38.2	11.8	21.9	34
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	2.7	97.3	0.0	0.0	74
N+1	1.5	4.6	87.7	6.2	6.2	65
N+2	3.6	7.1	69.6	19.6	24.6	56
N+3	4.9	9.8	85.4	0.0	24.6	41
N+4	6.3	12.5	75.0	6.3	29.3	32
N+5	7.7	11.5	57.7	23.1	45.6	26

TABLE 194.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	54.0	40.2	5.7	0.0	0.0	87
N+1	75.5	22.6	1.9	0.0	0.0	53
N+2	73.9	17.4	2.2	6.5	6.5	46
N+3	79.1	14.0	4.7	2.3	8.7	43
N+4	73.2	19.5	7.3	0.0	8.7	41
N+5	63.2	26.3	7.9	2.6	11.1	38
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.0	48.0	34.0	0.0	0.0	50
N+1	9.1	40.9	18.2	31.8	31.8	22
N+2	21.4	42.9	35.7	0.0	31.8	14
N+3	14.3	50.0	28.6	7.1	36.7	14
N+4	8.3	58.3	33.3	0.0	36.7	12
N+5	45.5	27.3	27.3	0.0	36.7	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	14
N+1	0.0	0.0	50.0	50.0	50.0	12
N+2	0.0	0.0	100.0	0.0	50.0	5
N+3	0.0	0.0	100.0	0.0	50.0	4
N+4	0.0	0.0	75.0	25.0	62.5	4
N+5	0.0	0.0	100.0	0.0	62.5	3

TABLE 195.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	29.0	51.6	19.4	0.0	0.0	31
N+1	70.6	11.8	5.9	11.8	11.8	17
N+2	66.7	6.7	20.0	6.7	17.6	15
N+3	64.3	14.3	21.4	0.0	17.6	14
N+4	57.1	14.3	21.4	7.1	23.5	14
N+5	50.0	25.0	16.7	8.3	29.9	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.0	32.0	60.0	0.0	0.0	25
N+1	6.3	18.8	31.3	43.8	43.8	16
N+2	28.6	14.3	57.1	0.0	43.8	7
N+3	28.6	14.3	42.9	14.3	51.8	7
N+4	0.0	60.0	40.0	0.0	51.8	5
N+5	0.0	40.0	60.0	0.0	51.8	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	2
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 196.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	68.8	25.0	6.3	0.0	0.0	48
N+1	69.0	27.6	3.4	0.0	0.0	29
N+2	69.0	24.1	0.0	6.9	6.9	29
N+3	76.0	20.0	0.0	4.0	10.6	25
N+4	77.3	18.2	4.5	0.0	10.6	22
N+5	66.7	28.6	4.8	0.0	10.6	21
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.4	60.9	21.7	0.0	0.0	23
N+1	11.1	55.6	22.2	11.1	11.1	9
N+2	0.0	71.4	28.6	0.0	11.1	7
N+3	0.0	71.4	28.6	0.0	11.1	7
N+4	0.0	71.4	28.6	0.0	11.1	7
N+5	66.7	16.7	16.7	0.0	11.1	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	80.0	20.0	20.0	5
N+1	0.0	0.0	0.0	100.0	100.0	3
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 197.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	28.6	57.1	14.3	0.0	0.0	21
N+1	86.7	0.0	0.0	13.3	13.3	15
N+2	84.6	0.0	7.7	7.7	20.0	13
N+3	83.3	8.3	8.3	0.0	20.0	12
N+4	70.0	20.0	10.0	0.0	20.0	10
N+5	60.0	30.0	0.0	10.0	28.0	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	46.7	46.7	6.7	6.7	15
N+1	10.0	20.0	30.0	40.0	44.0	10
N+2	40.0	20.0	40.0	0.0	44.0	5
N+3	40.0	20.0	40.0	0.0	44.0	5
N+4	0.0	75.0	25.0	0.0	44.0	4
N+5	0.0	50.0	50.0	0.0	44.0	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 198.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	91.4	7.0	1.4	0.2	0.2	499
N+1	86.4	11.7	1.9	0.0	0.2	463
N+2	79.7	15.8	4.3	0.2	0.4	438
N+3	77.1	15.9	7.0	0.0	0.4	402
N+4	73.6	19.3	6.8	0.3	0.7	383
N+5	70.5	19.5	9.6	0.3	1.0	353
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.5	71.9	8.6	0.0	0.0	221
N+1	24.1	62.7	11.3	1.9	1.9	212
N+2	28.6	53.6	17.3	0.5	2.4	196
N+3	32.8	46.6	17.8	2.9	5.2	174
N+4	31.0	50.0	17.1	1.9	7.0	158
N+5	39.8	42.9	16.5	0.8	7.7	133
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	1.0	90.5	8.6	8.6	105
N+1	1.2	9.5	84.5	4.8	12.9	84
N+2	2.8	15.3	73.6	8.3	20.2	72
N+3	5.2	13.8	81.0	0.0	20.2	58
N+4	7.8	17.6	72.5	2.0	21.7	51
N+5	7.7	28.2	56.4	7.7	27.8	39

TABLE 199.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	55.9	29.4	14.7	0.0	0.0	34
N+1	60.0	30.0	5.0	5.0	5.0	20
N+2	50.0	37.5	6.3	6.3	10.9	16
N+3	40.0	26.7	33.3	0.0	10.9	15
N+4	33.3	26.7	40.0	0.0	10.9	15
N+5	40.0	13.3	40.0	6.7	16.9	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.0	0.0	40.0	0.0	0.0	5
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	100.0	0.0	50.0	1
N+3	0.0	0.0	0.0	100.0	100.0	1
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 200.

RED MAPLE * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	76.0	8.0	16.0	0.0	0.0	25
N+1	61.5	23.1	7.7	7.7	7.7	13
N+2	60.0	30.0	0.0	10.0	16.9	10
N+3	55.6	22.2	22.2	0.0	16.9	9
N+4	50.0	12.5	37.5	0.0	16.9	8
N+5	33.3	16.7	33.3	16.7	30.8	6
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	50.0	25.0	0.0	0.0	4
N+1	50.0	50.0	0.0	0.0	0.0	2
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	100.0	100.0	1
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 201.

RED MAPLE * INTERMECIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITICN AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	92.5	6.2	1.4	0.0	0.0	146
N+1	90.9	6.6	2.5	0.0	0.0	121
N+2	82.3	9.7	7.1	0.9	0.9	113
N+3	81.5	8.3	9.3	0.9	1.8	108
N+4	80.4	10.3	9.3	0.0	1.8	107
N+5	77.9	11.6	9.5	1.1	2.8	95
FAIR CONDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	19.2	67.3	11.5	1.9	1.9	52
N+1	26.2	52.4	21.4	0.0	1.9	42
N+2	37.5	35.0	25.0	2.5	4.4	40
N+3	31.4	40.0	28.6	0.0	4.4	35
N+4	36.4	33.3	30.3	0.0	4.4	33
N+5	37.0	14.8	44.4	3.7	7.9	27
POCR CONDITICN AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	4.5	90.9	4.5	4.5	44
N+1	2.5	10.0	87.5	0.0	4.5	40
N+2	5.3	13.2	78.9	2.6	7.1	38
N+3	8.3	16.7	75.0	0.0	7.1	36
N+4	8.3	27.8	63.9	0.0	7.1	36
N+5	10.0	26.7	63.3	0.0	7.1	30

TABLE 202.

RED MAPLE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.3	28.3	9.4	0.9	0.9	106
N+1	53.0	31.8	10.6	4.5	5.4	66
N+2	54.9	25.5	15.7	3.9	9.2	51
N+3	56.3	20.8	18.8	4.2	12.9	48
N+4	61.0	24.4	7.3	7.3	19.3	41
N+5	58.3	33.3	8.3	0.0	19.3	36
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.5	38.7	53.2	1.6	1.6	62
N+1	10.0	30.0	36.7	23.3	24.6	30
N+2	5.9	29.4	52.9	11.8	33.4	17
N+3	7.7	23.1	53.8	15.4	43.7	13
N+4	9.1	27.3	63.6	0.0	43.7	11
N+5	9.1	18.2	72.7	0.0	43.7	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.1	93.8	3.1	3.1	32
N+1	5.3	0.0	52.6	42.1	43.9	19
N+2	0.0	9.1	72.7	18.2	54.1	11
N+3	0.0	11.1	55.6	33.3	69.4	9
N+4	0.0	0.0	100.0	0.0	69.4	4
N+5	0.0	0.0	100.0	0.0	69.4	4

TABLE 203.

RED MAPLE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	37.9	27.6	31.0	3.4	3.4	29
N+1	42.9	42.9	9.5	4.8	8.0	21
N+2	40.0	35.0	15.0	10.0	17.2	20
N+3	50.0	22.2	22.2	5.6	21.8	18
N+4	52.9	29.4	11.8	5.9	26.4	17
N+5	40.0	40.0	20.0	0.0	26.4	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	14.3	78.6	7.1	7.1	28
N+1	0.0	16.7	25.0	58.3	61.3	12
N+2	0.0	0.0	75.0	25.0	71.0	4
N+3	0.0	0.0	33.3	66.7	90.3	3
N+4	0.0	0.0	100.0	0.0	90.3	1
N+5	0.0	0.0	100.0	0.0	90.3	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	8
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	2
N+3	0.0	0.0	100.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	2
N+5	0.0	0.0	100.0	0.0	0.0	2

TABLE 204.

RED MAPLE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.2	32.5	6.3	0.0	0.0	80
N+1	47.6	31.0	16.7	4.8	4.8	42
N+2	55.9	17.6	26.5	0.0	4.8	34
N+3	57.6	15.2	21.2	6.1	10.5	33
N+4	56.5	21.7	13.0	8.7	18.3	23
N+5	56.3	31.3	12.5	0.0	18.3	16
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	7.9	36.8	55.3	0.0	0.0	38
N+1	13.6	31.8	36.4	18.2	18.2	22
N+2	0.0	30.0	60.0	10.0	26.4	10
N+3	0.0	14.3	71.4	14.3	36.9	7
N+4	0.0	16.7	83.3	0.0	36.9	6
N+5	0.0	0.0	100.0	0.0	36.9	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	80.0	20.0	20.0	15
N+1	0.0	0.0	87.5	12.5	30.0	8
N+2	0.0	0.0	66.7	33.3	53.3	6
N+3	0.0	25.0	50.0	25.0	65.0	4
N+4	0.0	0.0	100.0	0.0	65.0	2
N+5	0.0	0.0	100.0	0.0	65.0	2

TABLE 205.

RED MAPLE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOCC	FAIR	PCOR	CEAD	CUM. CEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	35.5	25.8	29.0	9.7	9.7	31
N+1	57.7	34.6	3.8	3.8	13.2	26
N+2	52.9	29.4	11.8	5.9	18.3	17
N+3	56.3	25.0	18.8	0.0	18.3	16
N+4	53.3	33.3	6.7	6.7	23.7	15
N+5	42.9	42.9	14.3	0.0	23.7	14
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	8.7	65.2	26.1	26.1	23
N+1	0.0	33.3	16.7	50.0	63.0	6
N+2	0.0	0.0	66.7	33.3	75.4	3
N+3	0.0	0.0	50.0	50.0	87.7	2
N+4	0.0	0.0	100.0	0.0	87.7	1
N+5	0.0	0.0	100.0	0.0	87.7	1
POOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	75.0	25.0	25.0	4
N+1	0.0	0.0	100.0	0.0	25.0	1
N+2	0.0	0.0	100.0	0.0	25.0	1
N+3	0.0	0.0	100.0	0.0	25.0	1
N+4	0.0	0.0	0.0	0.0	25.0	0
N+5	0.0	0.0	0.0	0.0	25.0	0

TABLE 206.

RED MAPLE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	86.8	11.1	2.1	0.0	0.0	288
N+1	79.8	16.7	3.1	0.4	0.4	258
N+2	73.0	19.3	7.3	0.4	0.8	233
N+3	68.8	21.6	7.7	1.9	2.7	208
N+4	65.1	24.0	9.9	1.0	3.7	192
N+5	62.0	25.2	12.9	0.0	3.7	163
FAIR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	16.0	76.0	6.7	1.3	1.3	300
N+1	20.6	65.9	11.1	2.4	3.7	252
N+2	20.9	59.6	18.3	1.3	4.9	230
N+3	21.3	59.9	16.9	1.9	6.8	207
N+4	25.1	55.3	18.1	1.5	8.2	199
N+5	27.6	50.0	21.8	0.6	8.7	174
POCR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	3.2	11.3	76.9	8.6	8.6	186
N+1	2.6	15.9	72.2	9.3	17.1	151
N+2	2.4	22.8	70.1	4.7	21.0	127
N+3	6.0	22.0	69.0	3.0	23.4	100
N+4	6.7	28.9	61.1	3.3	25.9	90
N+5	8.1	31.1	58.1	2.7	27.9	74

TABLE 207.

WHITE PINE

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.7	20.9	12.0	0.4	0.4	225
N+1	62.3	19.8	11.6	6.3	6.7	207
N+2	58.3	24.6	12.6	4.6	11.0	175
N+3	54.8	24.5	18.1	2.6	13.3	155
N+4	65.2	19.6	11.6	3.6	16.4	138
N+5	64.5	20.7	14.0	0.8	17.1	121
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.4	49.5	36.1	1.0	1.0	97
N+1	11.8	49.4	28.2	10.6	11.5	85
N+2	13.6	40.7	30.5	15.3	25.0	59
N+3	11.1	37.8	40.0	11.1	33.3	45
N+4	9.4	34.4	50.0	6.3	37.5	32
N+5	14.8	37.0	33.3	14.8	46.8	27
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.7	7.0	86.0	2.3	2.3	43
N+1	3.2	19.4	25.8	51.6	52.7	31
N+2	11.1	11.1	66.7	11.1	58.0	9
N+3	16.7	33.3	33.3	16.7	65.0	6
N+4	50.0	25.0	25.0	0.0	65.0	4
N+5	50.0	25.0	25.0	0.0	65.0	4

TABLE 208.

WHITE PINE

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.2	17.7	3.1	0.0	0.0	130
N+1	62.9	23.4	9.7	4.0	4.0	124
N+2	53.6	32.1	11.6	2.7	6.6	112
N+3	54.3	26.6	18.1	1.1	7.6	94
N+4	55.6	28.4	14.8	1.2	8.7	81
N+5	55.6	26.4	16.7	1.4	10.0	72
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.2	71.7	26.1	0.0	0.0	46
N+1	10.0	60.0	27.5	2.5	2.5	40
N+2	14.7	44.1	32.4	8.8	11.1	34
N+3	12.0	52.0	28.0	8.0	18.2	25
N+4	6.3	43.8	43.8	6.3	23.3	16
N+5	0.0	50.0	41.7	8.3	29.7	12
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.5	95.5	0.0	0.0	22
N+1	0.0	11.8	52.9	35.3	35.3	17
N+2	0.0	16.7	83.3	0.0	35.3	6
N+3	0.0	16.7	66.7	16.7	46.1	6
N+4	0.0	50.0	50.0	0.0	46.1	2
N+5	0.0	50.0	50.0	0.0	46.1	2

TABLE 209.

WHITE PINE

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.5	5.1	1.1	0.2	0.2	1929
N+1	91.7	6.7	1.2	0.3	0.5	1789
N+2	88.6	8.3	2.6	0.5	1.1	1679
N+3	86.2	10.5	2.7	0.6	1.7	1500
N+4	85.6	11.6	2.7	0.1	1.8	1356
N+5	82.6	13.2	4.0	0.2	2.1	1239
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	20.8	69.7	8.5	1.0	1.0	485
N+1	29.9	57.4	10.5	2.2	3.2	411
N+2	32.3	51.9	14.0	1.9	5.0	372
N+3	27.8	51.1	19.6	1.6	6.5	317
N+4	26.0	48.3	23.8	1.9	8.3	269
N+5	25.0	49.1	25.0	0.9	9.1	220
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.5	12.8	72.9	12.8	12.8	203
N+1	5.1	23.2	60.9	10.9	22.3	138
N+2	5.1	29.3	61.6	4.0	25.4	99
N+3	0.0	30.4	65.8	3.8	28.3	79
N+4	1.6	35.9	56.3	6.3	32.7	64
N+5	4.5	47.7	47.7	0.0	32.7	44

TABLE 210.

WHITE PINE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.2	19.4	6.5	0.0	0.0	62
N+1	67.2	23.0	8.2	1.6	1.6	61
N+2	69.2	19.2	11.5	0.0	1.6	52
N+3	68.6	21.6	7.8	2.0	3.6	51
N+4	70.0	20.0	4.0	6.0	9.4	50
N+5	72.1	23.3	2.3	2.3	11.5	43
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	3
N+1	0.0	100.0	0.0	0.0	0.0	3
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	100.0	0.0	0.0	0.0	2
N+4	0.0	50.0	50.0	0.0	0.0	2
N+5	50.0	0.0	50.0	0.0	0.0	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	0.0	75.0	0.0	0.0	4
N+1	50.0	0.0	0.0	50.0	50.0	2
N+2	100.0	0.0	0.0	0.0	50.0	1
N+3	100.0	0.0	0.0	0.0	50.0	1
N+4	100.0	0.0	0.0	0.0	50.0	1
N+5	100.0	0.0	0.0	0.0	50.0	1

TABLE 211.

WHITE PINE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	78.4	18.9	2.7	0.0	0.0	37
N+1	56.8	29.7	10.8	2.7	2.7	37
N+2	55.9	32.4	11.8	0.0	2.7	34
N+3	54.5	33.3	9.1	3.0	5.7	33
N+4	56.3	34.4	6.3	3.1	8.6	32
N+5	62.1	31.0	3.4	3.4	11.8	29
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 212.

WHITE PINE * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	96.8	2.8	0.3	0.1	0.1	990
N+1	96.3	3.2	0.5	0.0	0.1	916
N+2	93.0	4.6	2.1	0.2	0.3	862
N+3	92.1	5.7	1.8	0.4	0.7	757
N+4	92.4	5.7	1.9	0.0	0.7	668
N+5	89.3	6.4	3.9	0.3	1.0	637
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	21.5	74.7	3.8	0.0	0.0	79
N+1	38.5	50.8	10.8	0.0	0.0	65
N+2	52.5	32.8	14.8	0.0	0.0	61
N+3	54.0	34.0	10.0	2.0	2.0	50
N+4	60.5	23.7	15.8	0.0	2.0	38
N+5	51.4	28.6	20.0	0.0	2.0	35
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	7.1	78.6	14.3	14.3	28
N+1	0.0	18.8	75.0	6.3	19.6	16
N+2	0.0	30.8	69.2	0.0	19.6	13
N+3	0.0	40.0	60.0	0.0	19.6	10
N+4	0.0	60.0	40.0	0.0	19.6	5
N+5	0.0	80.0	20.0	0.0	19.6	5

TABLE 213.

WHITE PINE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	64.0	32.0	4.0	0.0	0.0	25
N+1	72.2	16.7	11.1	0.0	0.0	18
N+2	56.3	18.8	18.8	6.3	6.3	16
N+3	60.0	13.3	20.0	6.7	12.5	15
N+4	70.0	20.0	10.0	0.0	12.5	10
N+5	57.1	14.3	28.6	0.0	12.5	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	54.5	18.2	9.1	9.1	11
N+1	11.1	66.7	22.2	0.0	9.1	9
N+2	25.0	25.0	50.0	0.0	9.1	4
N+3	25.0	25.0	25.0	25.0	31.8	4
N+4	0.0	0.0	100.0	0.0	31.8	1
N+5	0.0	0.0	0.0	100.0	100.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 214.

WHITE PINE * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.0	7.1	0.0	0.9	0.9	112
N+1	91.3	8.7	0.0	0.0	0.9	103
N+2	84.0	12.0	3.0	1.0	1.9	100
N+3	76.7	20.0	1.1	2.2	4.1	90
N+4	84.6	14.1	1.3	0.0	4.1	78
N+5	77.0	14.8	8.2	0.0	4.1	61
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	15.6	68.8	15.6	0.0	0.0	32
N+1	21.7	47.8	26.1	4.3	4.3	23
N+2	23.8	33.3	33.3	9.5	13.5	21
N+3	18.8	18.8	62.5	0.0	13.5	16
N+4	8.3	33.3	58.3	0.0	13.5	12
N+5	9.1	36.4	54.5	0.0	13.5	11
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	0.0	83.3	16.7	16.7	12
N+1	0.0	20.0	80.0	0.0	16.7	5
N+2	0.0	25.0	75.0	0.0	16.7	4
N+3	0.0	25.0	75.0	0.0	16.7	4
N+4	25.0	50.0	25.0	0.0	16.7	4
N+5	33.3	33.3	33.3	0.0	16.7	3

TABLE 215.

WHITE PINE * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	63.0	33.3	3.7	0.0	0.0	27
N+1	81.5	18.5	0.0	0.0	0.0	27
N+2	72.0	24.0	4.0	0.0	0.0	25
N+3	60.9	26.1	13.0	0.0	0.0	23
N+4	68.2	13.6	13.6	4.5	4.5	22
N+5	55.0	20.0	25.0	0.0	4.5	20
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.1	63.6	27.3	0.0	0.0	11
N+1	25.0	50.0	25.0	0.0	0.0	8
N+2	16.7	33.3	50.0	0.0	0.0	6
N+3	0.0	16.7	66.7	16.7	16.7	6
N+4	0.0	25.0	50.0	25.0	37.5	4
N+5	0.0	33.3	33.3	33.3	58.3	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	75.0	25.0	25.0	4
N+1	0.0	0.0	0.0	100.0	100.0	2
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 216.

WHITE PINE * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.0	20.0	0.0	0.0	0.0	20
N+1	75.0	25.0	0.0	0.0	0.0	20
N+2	65.0	30.0	5.0	0.0	0.0	20
N+3	52.9	29.4	17.6	0.0	0.0	17
N+4	53.8	23.1	23.1	0.0	0.0	13
N+5	50.0	25.0	25.0	0.0	0.0	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	60.0	40.0	0.0	0.0	5
N+1	33.3	33.3	33.3	0.0	0.0	3
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	50.0	0.0	50.0	50.0	2
N+5	0.0	100.0	0.0	0.0	50.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	0.0	100.0	100.0	2
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 217.

WHITE PINE * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	87.8	7.4	4.3	0.5	0.5	376
N+1	86.7	8.7	2.9	1.7	2.3	346
N+2	85.3	10.6	2.8	1.2	3.5	320
N+3	80.6	13.4	4.9	1.1	4.5	283
N+4	80.2	14.7	4.3	0.8	5.2	258
N+5	79.6	16.6	3.4	0.4	5.6	235
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	17.0	67.0	12.3	3.8	3.8	106
N+1	39.1	41.4	12.6	6.9	10.4	87
N+2	39.4	42.3	12.7	5.6	15.5	71
N+3	28.0	46.0	22.0	4.0	18.8	50
N+4	32.4	35.3	26.5	5.9	23.6	34
N+5	25.0	50.0	21.4	3.6	26.3	28
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	18.2	66.7	15.2	15.2	33
N+1	4.3	52.2	26.1	17.4	29.9	23
N+2	6.7	60.0	33.3	0.0	29.9	15
N+3	0.0	35.7	57.1	7.1	34.9	14
N+4	0.0	46.2	30.8	23.1	49.9	13
N+5	16.7	50.0	33.3	0.0	49.9	6

TABLE 218.

WHITE PINE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	67.0	17.0	14.9	1.1	1.1	94
N+1	55.3	17.6	15.3	11.8	12.7	85
N+2	49.3	26.1	15.9	8.7	20.3	69
N+3	41.8	29.1	25.5	3.6	23.2	55
N+4	60.0	22.2	15.6	2.2	24.9	45
N+5	63.4	17.1	19.5	0.0	24.9	41
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.8	46.2	40.0	0.0	0.0	65
N+1	12.1	43.1	31.0	13.8	13.8	58
N+2	14.3	38.1	26.2	21.4	32.3	42
N+3	14.3	39.3	35.7	10.7	39.5	28
N+4	10.0	45.0	45.0	0.0	39.5	20
N+5	11.8	47.1	35.3	5.9	43.1	17
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	3.6	7.1	89.3	0.0	0.0	28
N+1	0.0	22.7	27.3	50.0	50.0	22
N+2	0.0	16.7	66.7	16.7	58.3	6
N+3	0.0	50.0	25.0	25.0	68.7	4
N+4	33.3	33.3	33.3	0.0	68.7	3
N+5	33.3	33.3	33.3	0.0	68.7	3

TABLE 219.

WHITE PINE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.4	15.7	3.9	0.0	0.0	51
N+1	57.1	24.5	10.2	8.2	8.2	49
N+2	47.6	31.0	14.3	7.1	14.7	42
N+3	55.2	20.7	24.1	0.0	14.7	29
N+4	54.2	25.0	20.8	0.0	14.7	24
N+5	50.0	22.7	27.3	0.0	14.7	22
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.8	75.0	22.2	0.0	0.0	36
N+1	9.1	63.6	24.2	3.0	3.0	33
N+2	16.7	46.7	26.7	10.0	12.7	30
N+3	13.6	54.5	27.3	4.5	16.7	22
N+4	7.1	42.9	50.0	0.0	16.7	14
N+5	0.0	45.5	45.5	9.1	24.3	11
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	7.1	92.9	0.0	0.0	14
N+1	0.0	16.7	50.0	33.3	33.3	12
N+2	0.0	33.3	66.7	0.0	33.3	3
N+3	0.0	33.3	33.3	33.3	55.6	3
N+4	0.0	50.0	50.0	0.0	55.6	2
N+5	0.0	50.0	50.0	0.0	55.6	2

TABLE 220.

WHITE PINE * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	89.3	10.0	0.7	0.0	0.0	291
N+1	84.1	13.3	2.6	0.0	0.0	270
N+2	80.2	13.8	5.3	0.8	0.8	247
N+3	79.0	16.2	4.4	0.4	1.2	229
N+4	75.2	19.7	5.0	0.0	1.2	218
N+5	68.1	25.3	6.6	0.0	1.2	182
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	26.0	66.1	7.3	0.6	0.6	177
N+1	29.4	62.7	7.2	0.7	1.2	153
N+2	28.9	59.2	11.3	0.7	1.9	142
N+3	24.6	57.7	16.2	1.5	3.4	130
N+4	22.0	55.9	20.3	1.7	5.1	118
N+5	20.2	55.1	23.6	1.1	6.1	89
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	3.3	13.0	73.9	9.8	9.8	92
N+1	7.1	15.7	68.6	8.6	17.5	70
N+2	8.0	20.0	66.0	6.0	22.5	50
N+3	0.0	25.0	70.0	5.0	26.3	40
N+4	0.0	22.6	77.4	0.0	26.3	31
N+5	0.0	40.9	59.1	0.0	26.3	22

TABLE 221.

HICKORY

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.3	17.2	3.4	0.0	0.0	58
N+1	74.5	9.1	9.1	7.3	7.3	55
N+2	74.5	13.7	7.8	3.9	10.9	51
N+3	65.1	18.6	11.6	4.7	15.1	43
N+4	71.8	12.8	15.4	0.0	15.1	39
N+5	68.4	15.8	15.8	0.0	15.1	38
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.3	73.3	13.3	0.0	0.0	15
N+1	0.0	40.0	60.0	0.0	0.0	10
N+2	0.0	40.0	20.0	40.0	40.0	10
N+3	0.0	50.0	50.0	0.0	40.0	4
N+4	0.0	66.7	33.3	0.0	40.0	3
N+5	0.0	66.7	0.0	33.3	60.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	7
N+1	0.0	0.0	100.0	0.0	0.0	7
N+2	0.0	0.0	71.4	28.6	28.6	7
N+3	0.0	0.0	100.0	0.0	28.6	4
N+4	0.0	0.0	100.0	0.0	28.6	4
N+5	0.0	0.0	100.0	0.0	28.6	4

TABLE 222.

HICKORY

DEFOLIATION HISTORY--LLH

YEAR	GOCC	FAIR	PCOR	DEAC	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NC.
GCCD CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	85.0	10.0	5.0	0.0	0.0	40
N+1	81.6	5.3	10.5	2.6	2.6	38
N+2	78.4	10.8	10.8	0.0	2.6	37
N+3	69.7	15.2	9.1	6.1	8.5	33
N+4	71.4	14.3	14.3	0.0	8.5	28
N+5	64.0	16.0	20.0	0.0	8.5	25
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	18.2	72.7	9.1	0.0	0.0	11
N+1	0.0	42.9	57.1	0.0	0.0	7
N+2	0.0	42.9	28.6	28.6	28.6	7
N+3	0.0	50.0	50.0	0.0	28.6	4
N+4	0.0	66.7	33.3	0.0	28.6	3
N+5	0.0	66.7	0.0	33.3	52.4	3
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	87.5	12.5	12.5	8
N+1	0.0	0.0	100.0	0.0	12.5	7
N+2	0.0	0.0	71.4	28.6	37.5	7
N+3	0.0	0.0	100.0	0.0	37.5	4
N+4	0.0	0.0	100.0	0.0	37.5	4
N+5	0.0	0.0	100.0	0.0	37.5	4

TABLE 223.

HICKORY

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	96.6	2.3	1.1	0.0	0.0	441
N+1	94.5	3.3	1.9	0.2	0.2	421
N+2	91.9	4.9	3.0	0.3	0.5	369
N+3	92.1	4.6	3.0	0.3	0.8	329
N+4	89.0	6.8	3.8	0.4	1.2	264
N+5	87.4	8.4	4.2	0.0	1.2	238
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	39.5	52.6	7.9	0.0	0.0	76
N+1	44.3	38.6	14.3	2.9	2.9	70
N+2	50.0	35.7	14.3	0.0	2.9	56
N+3	47.2	32.1	20.8	0.0	2.9	53
N+4	46.7	37.8	15.6	0.0	2.9	45
N+5	65.7	17.1	17.1	0.0	2.9	35
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	5.0	11.7	78.3	5.0	5.0	60
N+1	3.7	20.4	66.7	9.3	13.8	54
N+2	14.3	19.0	61.9	4.8	17.9	42
N+3	30.3	15.2	54.5	0.0	17.9	33
N+4	28.1	18.8	53.1	0.0	17.9	32
N+5	32.0	20.0	48.0	0.0	17.9	25

TABLE 224.

BEECH

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	CEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	49.1	48.1	2.8	0.0	0.0	1C6
N+1	87.4	10.7	1.0	1.0	1.0	1C3
N+2	88.7	8.2	2.1	1.0	2.0	97
N+3	81.5	13.6	4.9	0.0	2.0	81
N+4	82.2	13.7	2.7	1.4	3.3	73
N+5	75.4	19.3	3.5	1.8	5.0	57
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	16.7	83.3	0.0	0.0	0.0	12
N+1	50.0	41.7	8.3	0.0	0.0	12
N+2	45.5	36.4	18.2	0.0	0.0	11
N+3	25.0	25.0	50.0	0.0	0.0	8
N+4	25.0	50.0	25.0	0.0	0.0	8
N+5	37.5	37.5	25.0	0.0	0.0	8
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	100.0	0.0	0.0	0.0	1

TABLE 225.

BEECH

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.2	29.0	5.8	0.0	0.0	69
N+1	82.5	12.7	3.2	1.6	1.6	63
N+2	78.8	19.2	1.9	0.0	1.6	52
N+3	78.4	16.2	5.4	0.0	1.6	37
N+4	72.4	20.7	6.9	0.0	1.6	29
N+5	64.3	28.6	3.6	3.6	5.1	28
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	7
N+1	0.0	100.0	0.0	0.0	0.0	5
N+2	0.0	66.7	33.3	0.0	0.0	3
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	50.0	50.0	0.0	0.0	2
N+5	0.0	50.0	50.0	0.0	0.0	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 226.

BEECH

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	97.9	1.6	0.5	0.0	0.0	754
N+1	95.0	3.5	1.4	0.0	0.0	706
N+2	90.6	6.0	3.1	0.3	0.3	668
N+3	90.8	5.5	3.6	0.0	0.3	631
N+4	89.5	6.1	4.4	0.0	0.3	588
N+5	88.1	6.0	5.5	0.4	0.7	563
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.0	73.0	7.9	0.0	0.0	126
N+1	32.7	57.0	9.3	0.9	0.9	107
N+2	42.0	42.0	14.0	2.0	2.9	100
N+3	48.9	37.8	13.3	0.0	2.9	90
N+4	51.3	34.6	14.1	0.0	2.9	78
N+5	64.4	23.3	12.3	0.0	2.9	73
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	3.8	11.4	81.0	3.8	3.8	79
N+1	9.5	14.3	74.6	1.6	5.3	63
N+2	16.4	14.5	63.6	5.5	10.5	55
N+3	17.4	23.9	56.5	2.2	12.4	46
N+4	23.7	26.3	47.4	2.6	14.7	38
N+5	34.4	15.6	46.9	3.1	17.4	32

TABLE 227.

MIXED OAKS

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.8	25.6	8.2	0.3	0.3	4288
N+1	64.7	18.5	10.0	6.9	7.2	3276
N+2	67.7	17.6	10.7	4.0	11.0	2445
N+3	61.4	21.6	15.0	1.9	12.7	1645
N+4	61.4	22.7	14.4	1.5	14.0	1328
N+5	63.5	20.3	15.2	1.0	14.9	1071
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.7	49.4	31.6	1.3	1.3	1479
N+1	25.7	25.8	32.6	16.0	17.1	1099
N+2	27.5	25.2	36.3	10.9	26.2	622
N+3	32.2	25.1	39.1	3.6	28.8	338
N+4	32.0	22.4	42.0	3.6	31.3	250
N+5	20.5	27.1	49.4	3.0	33.4	166
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.4	6.9	89.0	2.7	2.7	899
N+1	1.8	4.9	61.9	31.5	33.3	556
N+2	3.5	4.7	76.4	15.4	43.5	254
N+3	2.1	7.0	83.2	7.7	47.9	143
N+4	2.0	10.8	81.4	5.9	51.0	102
N+5	7.6	8.9	82.3	1.3	51.6	79

TABLE 228.

MIXED OAKS

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	53.5	25.5	17.9	3.1	3.1	709
N+1	58.5	15.5	14.0	12.0	14.7	458
N+2	64.8	9.3	21.3	4.6	18.7	324
N+3	59.0	14.8	23.5	2.7	20.9	183
N+4	54.4	20.8	20.0	4.8	24.7	125
N+5	63.2	19.5	12.6	4.6	28.2	87
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.7	24.5	53.2	5.6	5.6	216
N+1	14.2	20.5	26.8	38.6	42.0	127
N+2	20.8	17.0	45.3	17.0	51.8	53
N+3	27.8	11.1	50.0	11.1	57.2	18
N+4	30.0	20.0	30.0	20.0	65.8	10
N+5	0.0	50.0	50.0	0.0	65.8	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	4.3	9.4	78.3	8.0	8.0	138
N+1	7.8	2.2	52.2	37.8	42.7	90
N+2	10.0	0.0	60.0	30.0	59.9	20
N+3	11.1	11.1	77.8	0.0	59.9	9
N+4	0.0	0.0	100.0	0.0	59.9	4
N+5	0.0	0.0	100.0	0.0	59.9	3

TABLE 229.

MIXED OAKS

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.5	18.6	46.4	17.5	17.5	97
N+1	7.7	17.9	43.6	30.8	42.9	39
N+2	15.4	0.0	76.9	7.7	47.3	13
N+3	40.0	0.0	60.0	0.0	47.3	5
N+4	66.7	0.0	33.3	0.0	47.3	3
N+5	50.0	0.0	50.0	0.0	47.3	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	7.5	20.0	55.0	17.5	17.5	40
N+1	0.0	18.2	36.4	45.5	55.0	22
N+2	12.5	0.0	75.0	12.5	60.6	8
N+3	0.0	0.0	100.0	0.0	60.6	4
N+4	0.0	0.0	66.7	33.3	73.7	3
N+5	0.0	0.0	100.0	0.0	73.7	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	95.0	5.0	5.0	20
N+1	0.0	7.7	38.5	53.8	56.2	13
N+2	0.0	0.0	75.0	25.0	67.1	4
N+3	0.0	0.0	100.0	0.0	67.1	1
N+4	0.0	0.0	100.0	0.0	67.1	1
N+5	0.0	0.0	0.0	0.0	67.1	0

TABLE 230.

MIXED OAKS

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	77.1	18.3	4.5	0.1	0.1	1614
N+1	68.9	19.5	9.5	2.1	2.2	1424
N+2	66.7	20.3	10.5	2.5	4.7	1169
N+3	60.5	23.2	14.4	1.9	6.4	806
N+4	57.7	25.7	15.7	0.9	7.3	650
N+5	53.9	27.6	18.6	0.0	7.3	555
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.6	52.6	33.3	0.6	0.6	544
N+1	16.4	34.5	42.4	6.7	7.2	420
N+2	21.1	31.5	38.8	8.5	15.1	317
N+3	25.5	29.8	43.6	1.1	16.0	188
N+4	20.3	29.7	46.6	3.4	18.8	148
N+5	17.1	31.6	50.4	0.9	19.5	117
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.4	3.9	94.5	1.1	1.1	457
N+1	1.4	4.2	75.7	18.7	19.6	284
N+2	2.2	5.6	80.9	11.2	28.6	178
N+3	1.8	8.3	87.2	2.8	30.6	109
N+4	1.2	11.8	80.0	7.1	35.5	85
N+5	7.4	10.3	80.9	1.5	36.4	68

TABLE 231.

MIXED OAKS

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	51.6	24.9	21.1	2.4	2.4	417
N+1	34.6	26.5	29.2	9.7	11.9	257
N+2	48.7	20.9	24.6	5.9	17.1	187
N+3	57.3	13.7	25.2	3.8	20.2	131
N+4	71.2	7.7	19.2	1.9	21.8	52
N+5	73.9	8.7	17.4	0.0	21.8	46
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.5	41.3	45.5	3.7	3.7	189
N+1	17.1	41.4	30.6	10.8	14.1	111
N+2	42.5	25.3	25.3	6.9	20.0	87
N+3	70.9	16.4	10.9	1.8	21.5	55
N+4	0.0	50.0	50.0	0.0	21.5	6
N+5	0.0	25.0	75.0	0.0	21.5	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	5.3	93.0	1.8	1.8	57
N+1	5.3	10.5	57.9	26.3	27.6	19
N+2	15.4	7.7	69.2	7.7	33.2	13
N+3	14.3	0.0	85.7	0.0	33.2	7
N+4	0.0	0.0	100.0	0.0	33.2	2
N+5	0.0	0.0	100.0	0.0	33.2	2

TABLE 232.

MIXED OAKS

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	42.2	35.6	18.2	4.0	4.0	275
N+1	51.0	20.5	19.0	9.5	13.1	200
N+2	62.3	11.6	23.3	2.7	15.5	146
N+3	60.0	15.0	21.7	3.3	18.3	60
N+4	40.0	34.3	22.9	2.9	20.7	35
N+5	38.5	38.5	19.2	3.8	23.7	26
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.4	30.7	49.6	7.3	7.3	137
N+1	21.5	19.0	32.9	26.6	31.9	79
N+2	27.5	22.5	35.0	15.0	42.2	40
N+3	35.7	7.1	57.1	0.0	42.2	14
N+4	33.3	11.1	44.4	11.1	48.6	9
N+5	0.0	33.3	66.7	0.0	48.6	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.0	10.3	83.5	5.2	5.2	97
N+1	3.2	4.8	69.8	22.2	26.2	63
N+2	7.1	0.0	57.1	35.7	52.6	14
N+3	25.0	0.0	75.0	0.0	52.6	4
N+4	0.0	0.0	100.0	0.0	52.6	3
N+5	0.0	0.0	100.0	0.0	52.6	1

TABLE 233.

MIXED OAKS

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.7	4.5	0.7	0.1	0.1	2108
N+1	92.1	5.8	1.8	0.3	0.4	1771
N+2	88.6	8.1	3.0	0.3	0.7	1450
N+3	86.9	9.5	3.5	0.1	0.8	1277
N+4	85.8	9.8	4.4	0.1	0.9	1046
N+5	83.2	10.9	5.9	0.0	0.9	851
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.6	69.8	10.1	0.4	0.4	759
N+1	35.0	50.4	13.7	1.0	1.3	629
N+2	39.4	45.2	15.0	0.4	1.7	500
N+3	44.7	40.0	15.1	0.2	2.0	445
N+4	51.8	33.4	14.5	0.3	2.2	392
N+5	50.0	32.0	16.9	1.1	3.3	278
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.0	9.2	87.0	2.8	2.8	675
N+1	3.1	19.5	74.2	3.3	6.0	550
N+2	4.6	24.4	69.7	1.4	7.3	435
N+3	9.2	28.2	62.5	0.0	7.3	379
N+4	18.0	28.2	52.9	0.9	8.1	333
N+5	18.7	25.3	55.6	0.5	8.6	198

TABLE 234.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	70.1	21.1	8.4	0.4	0.4	735
N+1	72.2	18.0	6.7	3.2	3.5	571
N+2	75.4	14.7	8.0	1.9	5.4	464
N+3	69.1	18.7	11.6	0.6	6.0	337
N+4	66.4	21.8	11.5	0.4	6.3	262
N+5	69.5	17.8	12.7	0.0	6.3	236
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.6	66.1	22.6	1.7	1.7	177
N+1	43.8	23.4	22.6	10.2	11.7	137
N+2	43.7	22.5	23.9	9.9	20.4	71
N+3	46.9	24.5	28.6	0.0	20.4	49
N+4	60.0	15.0	25.0	0.0	20.4	40
N+5	25.0	31.3	43.8	0.0	20.4	16
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.4	6.8	86.3	5.5	5.5	73
N+1	2.4	2.4	63.4	31.7	35.4	41
N+2	0.0	6.7	80.0	13.3	44.1	15
N+3	0.0	25.0	75.0	0.0	44.1	8
N+4	0.0	33.3	66.7	0.0	44.1	6
N+5	25.0	25.0	50.0	0.0	44.1	4

TABLE 235.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.7	26.7	20.0	2.7	2.7	75
N+1	74.5	7.8	9.8	7.8	10.3	51
N+2	75.0	13.9	11.1	0.0	10.3	36
N+3	63.2	10.5	26.3	0.0	10.3	19
N+4	43.8	31.3	25.0	0.0	10.3	16
N+5	64.3	21.4	14.3	0.0	10.3	14
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	36.4	40.9	4.5	4.5	22
N+1	45.5	27.3	27.3	0.0	4.5	11
N+2	44.4	22.2	22.2	11.1	15.2	9
N+3	0.0	0.0	100.0	0.0	15.2	3
N+4	0.0	0.0	66.7	33.3	43.4	3
N+5	0.0	0.0	100.0	0.0	43.4	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	20.0	80.0	0.0	0.0	10
N+1	33.3	16.7	16.7	33.3	33.3	6
N+2	100.0	0.0	0.0	0.0	33.3	1
N+3	0.0	0.0	0.0	0.0	33.3	0
N+4	0.0	0.0	0.0	0.0	33.3	0
N+5	0.0	0.0	0.0	0.0	33.3	0

TABLE 236.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	85.9	12.4	1.4	0.3	0.3	355
N+1	79.3	14.1	5.3	1.3	1.5	319
N+2	76.3	15.8	6.3	1.6	3.1	253
N+3	66.1	22.6	10.2	1.1	4.1	186
N+4	56.9	30.6	12.5	0.0	4.1	144
N+5	55.3	27.3	17.4	0.0	4.1	132
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.3	63.5	19.2	0.0	0.0	52
N+1	31.0	35.7	33.3	0.0	0.0	42
N+2	34.3	34.3	25.7	5.7	5.7	35
N+3	39.1	30.4	30.4	0.0	5.7	23
N+4	35.3	29.4	35.3	0.0	5.7	17
N+5	23.1	38.5	38.5	0.0	5.7	13
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	9.7	90.3	0.0	0.0	31
N+1	0.0	4.5	77.3	18.2	18.2	22
N+2	0.0	25.0	66.7	8.3	25.0	12
N+3	0.0	66.7	33.3	0.0	25.0	6
N+4	0.0	50.0	50.0	0.0	25.0	4
N+5	33.3	33.3	33.3	0.0	25.0	3

TABLE 237.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	65.8	21.1	13.2	0.0	0.0	76
N+1	41.1	26.8	23.2	8.9	8.9	56
N+2	46.9	20.4	28.6	4.1	12.6	49
N+3	51.3	12.8	35.9	0.0	12.6	39
N+4	76.5	5.9	17.6	0.0	12.6	17
N+5	86.7	6.7	6.7	0.0	12.6	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	11.4	70.5	18.2	0.0	0.0	44
N+1	33.3	46.2	15.4	5.1	5.1	39
N+2	61.1	22.2	13.9	2.8	7.8	36
N+3	86.2	10.3	3.4	0.0	7.8	29
N+4	0.0	100.0	0.0	0.0	7.8	2
N+5	0.0	50.0	50.0	0.0	7.8	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	22.2	77.8	0.0	0.0	9
N+1	20.0	0.0	60.0	20.0	20.0	5
N+2	25.0	0.0	50.0	25.0	40.0	4
N+3	33.3	0.0	66.7	0.0	40.0	3
N+4	0.0	0.0	0.0	0.0	40.0	0
N+5	0.0	0.0	0.0	0.0	40.0	0

TABLE 238.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	55.9	26.5	14.7	2.9	2.9	34
N+1	78.6	7.1	7.1	7.1	9.9	28
N+2	78.9	5.3	15.8	0.0	9.9	19
N+3	40.0	20.0	40.0	0.0	9.9	5
N+4	0.0	50.0	50.0	0.0	9.9	4
N+5	0.0	66.7	33.3	0.0	9.9	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	31.3	43.8	0.0	0.0	16
N+1	50.0	30.0	20.0	0.0	0.0	10
N+2	37.5	37.5	25.0	0.0	0.0	8
N+3	0.0	0.0	100.0	0.0	0.0	3
N+4	0.0	0.0	66.7	33.3	33.3	3
N+5	0.0	0.0	100.0	0.0	33.3	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	28.6	71.4	0.0	0.0	7
N+1	16.7	16.7	50.0	16.7	16.7	6
N+2	0.0	0.0	100.0	0.0	16.7	1
N+3	0.0	0.0	0.0	0.0	16.7	0
N+4	0.0	0.0	0.0	0.0	16.7	0
N+5	0.0	0.0	0.0	0.0	16.7	0

TABLE 239.

MIXED OAKS * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	97.5	2.5	0.0	0.0	0.0	406
N+1	95.8	3.6	0.6	0.0	0.0	332
N+2	92.5	5.5	2.0	0.0	0.0	254
N+3	91.4	5.0	3.6	0.0	0.0	221
N+4	90.4	4.8	4.8	0.0	0.0	187
N+5	86.8	5.1	8.1	0.0	0.0	136
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	21.7	65.2	13.0	0.0	0.0	115
N+1	43.5	43.5	13.0	0.0	0.0	92
N+2	43.1	40.3	16.7	0.0	0.0	72
N+3	55.2	28.4	16.4	0.0	0.0	67
N+4	60.0	26.7	13.3	0.0	0.0	60
N+5	56.1	24.4	19.5	0.0	0.0	41
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	10.7	89.3	0.0	0.0	75
N+1	5.0	26.7	68.3	0.0	0.0	60
N+2	8.9	33.3	57.8	0.0	0.0	45
N+3	20.5	30.8	48.7	0.0	0.0	39
N+4	31.4	37.1	31.4	0.0	0.0	35
N+5	33.3	38.9	27.8	0.0	0.0	18

TABLE 240.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	68.0	24.5	7.4	0.1	0.1	1556
N+1	73.4	15.5	8.5	2.5	2.7	1065
N+2	75.8	14.5	8.4	1.3	3.9	834
N+3	70.6	17.6	11.8	0.0	3.9	574
N+4	70.1	18.9	10.1	0.8	4.8	475
N+5	69.2	18.0	12.5	0.3	5.0	367
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.7	48.3	32.7	0.3	0.3	379
N+1	23.9	31.8	35.3	9.0	9.3	255
N+2	26.8	30.6	36.3	6.4	15.0	157
N+3	26.2	31.3	42.5	0.0	15.0	80
N+4	17.5	35.1	45.6	1.8	16.5	57
N+5	14.9	38.3	44.7	2.1	18.3	47
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	7.0	92.0	1.0	1.0	199
N+1	0.0	7.0	72.1	20.9	21.7	86
N+2	2.3	0.0	93.0	4.7	25.4	43
N+3	3.0	6.1	90.9	0.0	25.4	33
N+4	0.0	8.3	87.5	4.2	28.5	24
N+5	10.0	0.0	90.0	0.0	28.5	20

TABLE 241.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.3	24.6	17.9	1.2	1.2	341
N+1	67.8	16.8	9.8	5.6	6.7	214
N+2	75.8	8.3	12.7	3.2	9.7	157
N+3	69.2	15.4	15.4	0.0	9.7	91
N+4	70.0	16.7	10.0	3.3	12.7	60
N+5	72.5	17.5	7.5	2.5	14.9	40
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.6	28.8	59.6	1.9	1.9	52
N+1	19.2	19.2	34.6	26.9	28.3	26
N+2	25.0	0.0	66.7	8.3	34.3	12
N+3	75.0	0.0	25.0	0.0	34.3	4
N+4	100.0	0.0	0.0	0.0	34.3	3
N+5	0.0	0.0	0.0	0.0	34.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.9	93.1	0.0	0.0	29
N+1	0.0	5.0	70.0	25.0	25.0	20
N+2	20.0	0.0	80.0	0.0	25.0	5
N+3	33.3	0.0	66.7	0.0	25.0	3
N+4	0.0	0.0	100.0	0.0	25.0	2
N+5	0.0	0.0	100.0	0.0	25.0	2

TABLE 242.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.0	18.0	46.0	20.0	20.0	50
N+1	13.3	13.3	60.0	13.3	30.7	15
N+2	0.0	0.0	100.0	0.0	30.7	4
N+3	0.0	0.0	100.0	0.0	30.7	1
N+4	0.0	0.0	100.0	0.0	30.7	1
N+5	0.0	0.0	100.0	0.0	30.7	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	27.3	45.5	27.3	27.3	11
N+1	0.0	20.0	40.0	40.0	56.4	5
N+2	0.0	0.0	100.0	0.0	56.4	1
N+3	0.0	0.0	0.0	0.0	56.4	0
N+4	0.0	0.0	0.0	0.0	56.4	0
N+5	0.0	0.0	0.0	0.0	56.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	66.7	33.3	33.3	3
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 243.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.7	15.4	3.7	0.2	0.2	545
N+1	74.2	16.3	9.1	0.4	0.6	473
N+2	70.7	17.3	10.5	1.5	2.1	399
N+3	64.6	19.8	15.6	0.0	2.1	288
N+4	63.6	21.2	14.4	0.8	2.9	236
N+5	56.8	24.0	19.1	0.0	2.9	183
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.1	53.8	30.8	1.3	1.3	156
N+1	12.1	41.4	44.0	2.6	3.8	116
N+2	12.2	41.1	43.3	3.3	7.0	90
N+3	13.0	37.0	50.0	0.0	7.0	54
N+4	7.0	39.5	51.2	2.3	9.2	43
N+5	10.3	38.5	48.7	2.6	11.5	39
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	5.2	93.8	1.0	1.0	97
N+1	0.0	4.2	83.3	12.5	13.4	48
N+2	0.0	0.0	96.9	3.1	16.1	32
N+3	0.0	4.0	96.0	0.0	16.1	25
N+4	0.0	10.0	85.0	5.0	20.3	20
N+5	11.8	0.0	88.2	0.0	20.3	17

TABLE 244.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	57.9	21.5	19.8	0.8	0.8	121
N+1	49.3	28.2	18.3	4.2	5.0	71
N+2	64.7	23.5	9.8	2.0	6.9	51
N+3	80.6	8.3	11.1	0.0	6.9	36
N+4	70.6	11.8	17.6	0.0	6.9	17
N+5	70.6	11.8	17.6	0.0	6.9	17
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.9	33.3	52.8	0.0	0.0	36
N+1	18.8	43.8	37.5	0.0	0.0	16
N+2	50.0	25.0	16.7	8.3	8.3	12
N+3	60.0	40.0	0.0	0.0	8.3	5
N+4	0.0	0.0	0.0	0.0	8.3	0
N+5	0.0	0.0	0.0	0.0	8.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.7	93.3	0.0	0.0	15
N+1	0.0	20.0	80.0	0.0	0.0	5
N+2	20.0	20.0	60.0	0.0	0.0	5
N+3	0.0	0.0	100.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 245.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	33.1	43.2	22.0	1.7	1.7	118
N+1	45.1	29.6	21.1	4.2	5.8	71
N+2	60.7	8.9	26.8	3.6	9.2	56
N+3	66.7	16.7	16.7	0.0	9.2	30
N+4	46.2	38.5	15.4	0.0	9.2	13
N+5	50.0	37.5	12.5	0.0	9.2	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.8	28.2	56.4	2.6	2.6	39
N+1	37.5	0.0	31.3	31.3	33.0	16
N+2	50.0	0.0	37.5	12.5	41.4	8
N+3	80.0	0.0	20.0	0.0	41.4	5
N+4	100.0	0.0	0.0	0.0	41.4	3
N+5	0.0	0.0	0.0	0.0	41.4	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	12.5	87.5	0.0	0.0	16
N+1	0.0	8.3	91.7	0.0	0.0	12
N+2	25.0	0.0	75.0	0.0	0.0	4
N+3	50.0	0.0	50.0	0.0	0.0	2
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 246.

MIXED OAKS * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.4	4.5	1.0	0.1	0.1	803
N+1	91.8	5.4	2.3	0.4	0.6	683
N+2	87.2	8.7	4.0	0.2	0.7	578
N+3	85.0	10.7	4.3	0.0	0.7	506
N+4	83.4	12.3	4.3	0.0	0.7	416
N+5	80.9	14.9	4.3	0.0	0.7	350
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	18.1	73.4	8.1	0.4	0.4	248
N+1	35.2	52.9	11.9	0.0	0.4	210
N+2	47.3	40.8	11.8	0.0	0.4	169
N+3	52.7	38.7	8.7	0.0	0.4	150
N+4	62.6	27.5	9.9	0.0	0.4	131
N+5	60.9	27.2	8.7	3.3	3.7	92
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.1	7.7	90.6	0.6	0.6	181
N+1	3.2	21.5	74.7	0.6	1.2	158
N+2	4.3	23.2	71.7	0.7	1.9	138
N+3	9.8	29.3	61.0	0.0	1.9	123
N+4	20.0	29.6	50.4	0.0	1.9	115
N+5	20.6	20.6	58.8	0.0	1.9	68

TABLE 247.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	66.9	25.3	7.4	0.5	0.5	1059
N+1	62.0	18.5	10.5	9.0	9.4	888
N+2	63.1	18.6	12.2	6.2	15.0	650
N+3	54.5	23.0	18.2	4.4	18.7	435
N+4	56.0	24.7	17.2	2.0	20.4	348
N+5	58.1	25.4	14.7	1.8	21.8	272
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.8	55.8	22.7	1.7	1.7	353
N+1	29.4	24.8	26.2	19.6	20.9	286
N+2	31.6	24.7	32.3	11.4	30.0	158
N+3	44.3	25.8	26.8	3.1	32.1	97
N+4	45.9	20.3	29.7	4.1	34.9	74
N+5	39.0	14.6	41.5	4.9	38.0	41
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.3	5.8	85.5	6.4	6.4	173
N+1	2.6	3.4	67.2	26.7	31.4	116
N+2	7.0	1.8	70.2	21.1	45.8	57
N+3	3.8	7.7	80.8	7.7	50.0	26
N+4	0.0	11.1	77.8	11.1	55.6	18
N+5	7.1	14.3	78.6	0.0	55.6	14

TABLE 248.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	57.0	21.5	15.6	5.9	5.9	135
N+1	52.8	13.5	12.4	21.3	26.0	89
N+2	46.7	6.7	40.0	6.7	30.9	60
N+3	40.5	13.5	35.1	10.8	38.4	37
N+4	36.0	20.0	36.0	8.0	43.3	25
N+5	37.5	37.5	12.5	12.5	50.4	16
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	11.4	59.1	4.5	4.5	44
N+1	17.2	24.1	17.2	41.4	44.0	29
N+2	18.2	27.3	27.3	27.3	59.3	11
N+3	0.0	0.0	100.0	0.0	59.3	1
N+4	0.0	0.0	0.0	0.0	59.3	0
N+5	0.0	0.0	0.0	0.0	59.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.9	6.9	65.5	20.7	20.7	29
N+1	10.5	0.0	68.4	21.1	37.4	19
N+2	0.0	0.0	100.0	0.0	37.4	2
N+3	0.0	0.0	100.0	0.0	37.4	1
N+4	0.0	0.0	100.0	0.0	37.4	1
N+5	0.0	0.0	0.0	0.0	37.4	0

TABLE 249.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	28.6	14.3	42.9	14.3	14.3	21
N+1	0.0	27.3	27.3	45.5	53.2	11
N+2	20.0	0.0	60.0	20.0	62.6	5
N+3	50.0	0.0	50.0	0.0	62.6	2
N+4	100.0	0.0	0.0	0.0	62.6	1
N+5	0.0	0.0	0.0	0.0	62.6	0
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.0	0.0	40.0	40.0	40.0	5
N+1	0.0	0.0	33.3	66.7	80.0	3
N+2	0.0	0.0	100.0	0.0	80.0	1
N+3	0.0	0.0	100.0	0.0	80.0	1
N+4	0.0	0.0	100.0	0.0	80.0	1
N+5	0.0	0.0	0.0	0.0	80.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	2
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 250.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	73.0	21.4	5.6	0.0	0.0	426
N+1	64.2	20.6	11.1	4.1	4.1	388
N+2	63.5	22.4	9.5	4.6	8.5	304
N+3	57.4	24.9	14.2	3.6	11.8	197
N+4	58.3	26.2	13.1	2.4	13.9	168
N+5	55.6	30.5	13.9	0.0	13.9	151
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.1	60.2	22.8	0.0	0.0	123
N+1	20.2	32.7	34.6	12.5	12.5	104
N+2	33.3	27.5	27.5	11.6	22.6	69
N+3	44.7	23.4	29.8	2.1	24.3	47
N+4	38.9	22.2	30.6	8.3	30.6	36
N+5	36.0	24.0	40.0	0.0	30.6	25
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.9	1.9	97.2	0.0	0.0	106
N+1	1.6	6.3	74.6	17.5	17.5	63
N+2	4.9	7.3	65.9	22.0	35.6	41
N+3	5.3	10.5	84.2	0.0	35.6	19
N+4	0.0	12.5	75.0	12.5	43.6	16
N+5	7.7	15.4	76.9	0.0	43.6	13

TABLE 251.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	53.3	24.2	17.5	5.0	5.0	120
N+1	32.9	21.9	31.5	13.7	18.0	73
N+2	48.3	19.0	24.1	8.6	25.1	58
N+3	51.3	17.9	25.6	5.1	28.9	39
N+4	75.0	8.3	16.7	0.0	28.9	12
N+5	70.0	10.0	20.0	0.0	28.9	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	52.1	35.4	4.2	4.2	48
N+1	9.1	54.5	30.3	6.1	10.0	33
N+2	31.0	31.0	31.0	6.9	16.2	29
N+3	58.8	17.6	17.6	5.9	21.1	17
N+4	0.0	50.0	50.0	0.0	21.1	2
N+5	0.0	0.0	100.0	0.0	21.1	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	92.3	7.7	7.7	13
N+1	0.0	0.0	50.0	50.0	53.8	4
N+2	0.0	0.0	100.0	0.0	53.8	2
N+3	0.0	0.0	0.0	0.0	53.8	0
N+4	0.0	0.0	0.0	0.0	53.8	0
N+5	0.0	0.0	0.0	0.0	53.8	0

TABLE 252.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.0	23.6	9.1	7.3	7.3	55
N+1	62.2	8.9	11.1	17.8	23.8	45
N+2	67.9	10.7	17.9	3.6	26.5	28
N+3	37.5	12.5	25.0	25.0	44.9	8
N+4	16.7	33.3	50.0	0.0	44.9	6
N+5	0.0	80.0	20.0	0.0	44.9	5
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	17.9	21.4	42.9	17.9	17.9	28
N+1	22.2	27.8	22.2	27.8	40.7	18
N+2	33.3	33.3	11.1	22.2	53.9	9
N+3	0.0	0.0	100.0	0.0	53.9	1
N+4	0.0	0.0	100.0	0.0	53.9	1
N+5	0.0	0.0	0.0	0.0	53.9	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	3.8	7.7	84.6	3.8	3.8	26
N+1	5.6	5.6	72.2	16.7	19.9	18
N+2	0.0	0.0	100.0	0.0	19.9	1
N+3	0.0	0.0	100.0	0.0	19.9	1
N+4	0.0	0.0	100.0	0.0	19.9	1
N+5	0.0	0.0	0.0	0.0	19.9	0

TABLE 253.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	93.2	6.2	0.4	0.2	0.2	483
N+1	89.5	9.0	1.3	0.3	0.5	399
N+2	87.1	10.1	2.2	0.6	1.1	317
N+3	86.1	10.2	3.3	0.4	1.4	274
N+4	85.5	8.4	5.6	0.5	1.9	214
N+5	83.6	7.3	9.0	0.0	1.9	177
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.1	71.1	9.8	0.0	0.0	173
N+1	39.7	40.4	18.5	1.4	1.4	146
N+2	40.5	41.4	18.1	0.0	1.4	116
N+3	43.6	35.1	21.3	0.0	1.4	94
N+4	55.2	24.1	20.7	0.0	1.4	87
N+5	50.0	27.4	22.6	0.0	1.4	62
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.7	11.0	82.1	6.2	6.2	145
N+1	3.9	21.6	69.6	4.9	10.8	102
N+2	6.6	23.7	65.8	3.9	14.3	76
N+3	9.7	32.3	58.1	0.0	14.3	62
N+4	25.0	31.3	43.8	0.0	14.3	48
N+5	26.1	21.7	47.8	4.3	18.1	23

TABLE 254.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	61.9	30.1	7.3	0.8	0.8	396
N+1	55.5	19.1	11.7	13.7	14.4	299
N+2	62.6	18.4	12.1	6.8	20.2	190
N+3	53.8	26.5	17.4	2.3	22.0	132
N+4	51.4	27.6	19.0	1.9	23.5	105
N+5	61.9	19.0	17.9	1.2	24.4	84
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.5	45.2	38.1	1.3	1.3	155
N+1	17.4	22.9	40.4	19.3	20.3	109
N+2	22.6	21.0	38.7	17.7	34.4	62
N+3	27.3	45.5	27.3	0.0	34.4	22
N+4	17.6	35.3	41.2	5.9	38.3	17
N+5	26.7	40.0	33.3	0.0	38.3	15
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	3.1	5.2	89.7	2.1	2.1	97
N+1	1.6	6.6	55.7	36.1	37.4	61
N+2	0.0	3.6	82.1	14.3	46.3	28
N+3	0.0	0.0	92.9	7.1	50.2	14
N+4	12.5	0.0	87.5	0.0	50.2	8
N+5	14.3	0.0	85.7	0.0	50.2	7

TABLE 255.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.7	32.9	16.5	5.9	5.9	85
N+1	42.4	16.9	20.3	20.3	25.0	59
N+2	55.0	12.5	25.0	7.5	30.6	40
N+3	68.2	9.1	22.7	0.0	30.6	22
N+4	56.3	18.8	25.0	0.0	30.6	16
N+5	75.0	0.0	16.7	8.3	36.4	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.7	21.4	50.0	17.9	17.9	28
N+1	16.7	8.3	25.0	50.0	58.9	12
N+2	40.0	0.0	40.0	20.0	67.1	5
N+3	66.7	0.0	33.3	0.0	67.1	3
N+4	0.0	100.0	0.0	0.0	67.1	1
N+5	0.0	100.0	0.0	0.0	67.1	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	21.1	68.4	10.5	10.5	19
N+1	0.0	0.0	54.5	45.5	51.2	11
N+2	0.0	0.0	50.0	50.0	75.6	4
N+3	0.0	0.0	100.0	0.0	75.6	1
N+4	0.0	0.0	0.0	0.0	75.6	0
N+5	0.0	0.0	0.0	0.0	75.6	0

TABLE 256.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	74.3	24.8	0.9	0.0	0.0	109
N+1	62.4	23.7	8.6	5.4	5.4	93
N+2	60.8	25.3	10.1	3.8	9.0	79
N+3	43.9	29.8	21.1	5.3	13.8	57
N+4	39.0	29.3	31.7	0.0	13.8	41
N+5	41.7	30.6	27.8	0.0	13.8	36
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	16.1	41.9	41.9	0.0	0.0	62
N+1	9.8	31.7	56.1	2.4	2.4	41
N+2	15.6	31.3	43.8	9.4	11.6	32
N+3	16.7	58.3	25.0	0.0	11.6	12
N+4	18.2	45.5	36.4	0.0	11.6	11
N+5	20.0	40.0	40.0	0.0	11.6	10
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.6	1.6	93.4	3.3	3.3	61
N+1	0.0	0.0	70.6	29.4	31.7	34
N+2	0.0	0.0	94.1	5.9	35.7	17
N+3	0.0	0.0	91.7	8.3	41.1	12
N+4	12.5	0.0	87.5	0.0	41.1	8
N+5	16.7	0.0	83.3	0.0	41.1	6

TABLE 257.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	32.6	37.0	28.3	2.2	2.2	46
N+1	11.5	26.9	53.8	7.7	9.7	26
N+2	27.3	9.1	45.5	18.2	26.1	11
N+3	50.0	33.3	16.7	0.0	26.1	6
N+4	100.0	0.0	0.0	0.0	26.1	1
N+5	100.0	0.0	0.0	0.0	26.1	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.5	10.5	68.4	10.5	10.5	19
N+1	0.0	20.0	40.0	40.0	46.3	5
N+2	0.0	33.3	33.3	33.3	54.2	3
N+3	0.0	100.0	0.0	0.0	64.2	1
N+4	0.0	0.0	0.0	0.0	64.2	0
N+5	0.0	0.0	0.0	0.0	64.2	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	6
N+1	0.0	100.0	0.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 258.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	29.0	45.2	16.1	9.7	9.7	31
N+1	46.2	19.2	19.2	15.4	23.6	26
N+2	61.9	14.3	19.0	4.8	27.2	21
N+3	77.8	11.1	11.1	0.0	27.2	9
N+4	71.4	28.6	0.0	0.0	27.2	7
N+5	71.4	0.0	14.3	14.3	37.6	7
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.9	41.2	41.2	11.8	11.8	17
N+1	20.0	20.0	50.0	10.0	20.6	10
N+2	25.0	0.0	75.0	0.0	20.6	4
N+3	33.3	0.0	66.7	0.0	20.6	3
N+4	0.0	100.0	0.0	0.0	20.6	1
N+5	0.0	100.0	0.0	0.0	20.6	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	18.8	75.0	6.3	6.3	16
N+1	0.0	0.0	62.5	37.5	41.4	8
N+2	0.0	0.0	33.3	66.7	80.5	3
N+3	0.0	0.0	0.0	0.0	80.5	0
N+4	0.0	0.0	0.0	0.0	80.5	0
N+5	0.0	0.0	0.0	0.0	80.5	0

TABLE 259.

MIXED OAKS * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	98.0	1.5	0.5	0.0	0.0	204
N+1	97.7	1.7	0.6	0.0	0.0	177
N+2	95.2	3.4	1.4	0.0	0.0	146
N+3	94.9	4.3	0.7	0.0	0.0	138
N+4	96.6	3.4	0.0	0.0	0.0	117
N+5	94.8	4.1	1.0	0.0	0.0	97
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	32.0	62.7	4.0	1.3	1.3	75
N+1	44.6	50.0	5.4	0.0	1.3	56
N+2	46.5	44.2	9.3	0.0	1.3	43
N+3	57.5	35.0	5.0	2.5	3.8	40
N+4	56.7	36.7	6.7	0.0	3.8	30
N+5	59.1	36.4	4.5	0.0	3.8	22
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.9	15.4	78.8	3.8	3.8	52
N+1	5.6	25.0	66.7	2.8	6.5	36
N+2	6.7	36.7	56.7	0.0	6.5	30
N+3	8.0	48.0	44.0	0.0	6.5	25
N+4	17.4	30.4	47.8	4.3	10.6	23
N+5	35.7	28.6	35.7	0.0	10.6	14

TABLE 260.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	55.1	31.2	13.3	0.4	0.4	481
N+1	44.3	25.4	16.2	14.2	14.5	402
N+2	44.2	28.3	18.6	8.9	22.2	269
N+3	39.3	31.0	24.1	5.5	26.5	145
N+4	41.7	26.7	26.7	5.0	30.1	120
N+5	46.4	17.5	32.0	4.1	33.0	97
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	20.5	38.9	38.6	1.9	1.9	370
N+1	19.9	23.1	36.7	20.3	21.8	281
N+2	21.3	21.9	43.2	13.5	32.4	155
N+3	18.1	13.3	57.8	10.8	39.7	83
N+4	14.3	14.3	64.3	7.1	44.0	56
N+5	7.1	21.4	66.7	4.8	46.7	42
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.5	7.6	90.0	0.9	0.9	331
N+1	2.1	4.6	56.7	36.6	37.1	238
N+2	3.9	7.8	71.8	16.5	47.5	103
N+3	1.8	3.5	80.7	14.0	54.9	57
N+4	2.4	9.5	81.0	7.1	58.1	42
N+5	3.2	12.9	80.6	3.2	59.4	31

TABLE 261.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	49.2	23.8	22.2	4.8	4.8	63
N+1	28.9	18.4	31.6	21.1	24.8	38
N+2	44.4	7.4	37.0	11.1	33.2	27
N+3	16.7	25.0	50.0	8.3	38.7	12
N+4	14.3	28.6	28.6	28.6	56.2	7
N+5	50.0	0.0	50.0	0.0	56.2	4
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.3	24.6	49.2	4.9	4.9	61
N+1	2.4	21.4	26.2	50.0	52.5	42
N+2	0.0	16.7	58.3	25.0	64.3	12
N+3	0.0	33.3	33.3	33.3	76.2	6
N+4	0.0	50.0	0.0	50.0	88.1	2
N+5	0.0	100.0	0.0	0.0	88.1	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.7	6.5	78.3	6.5	6.5	46
N+1	10.0	0.0	36.7	53.3	56.4	30
N+2	0.0	0.0	57.1	42.9	75.1	7
N+3	0.0	25.0	75.0	0.0	75.1	4
N+4	0.0	0.0	100.0	0.0	75.1	1
N+5	0.0	0.0	100.0	0.0	75.1	1

TABLE 262.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	60.9	26.3	12.8	0.0	0.0	156
N+1	45.8	35.1	16.8	2.3	2.3	131
N+2	45.7	30.2	23.3	0.9	3.1	116
N+3	51.5	26.5	17.6	4.4	7.4	68
N+4	47.2	24.5	28.3	0.0	7.4	53
N+5	44.4	24.4	31.1	0.0	7.4	45
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	9.4	45.3	44.5	0.8	0.8	128
N+1	16.8	27.7	46.5	8.9	9.6	101
N+2	18.8	23.7	45.0	12.5	20.9	80
N+3	17.8	20.0	60.0	2.2	22.7	45
N+4	11.4	20.0	65.7	2.9	24.9	35
N+5	7.7	23.1	69.2	0.0	24.9	26
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	4.1	94.6	1.4	1.4	148
N+1	2.7	4.5	72.7	20.0	21.1	110
N+2	2.9	5.7	81.4	10.0	29.0	70
N+3	2.3	0.0	93.0	4.7	32.3	43
N+4	0.0	8.8	82.4	8.8	38.3	34
N+5	0.0	14.8	81.5	3.7	40.5	27

TABLE 263.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	21.3	34.0	40.4	4.3	4.3	47
N+1	13.8	31.0	37.9	17.2	20.8	29
N+2	23.5	29.4	41.2	5.9	25.4	17
N+3	27.3	9.1	36.4	27.3	45.8	11
N+4	40.0	0.0	40.0	20.0	56.6	5
N+5	33.3	0.0	66.7	0.0	56.6	3
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.7	16.2	73.0	8.1	8.1	37
N+1	0.0	11.8	52.9	35.3	40.5	17
N+2	0.0	16.7	66.7	16.7	50.5	6
N+3	33.3	0.0	66.7	0.0	50.5	3
N+4	0.0	0.0	100.0	0.0	50.5	2
N+5	0.0	0.0	100.0	0.0	50.5	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	13
N+1	0.0	0.0	50.0	50.0	50.0	4
N+2	0.0	0.0	100.0	0.0	50.0	2
N+3	0.0	0.0	100.0	0.0	50.0	2
N+4	0.0	0.0	100.0	0.0	50.0	1
N+5	0.0	0.0	100.0	0.0	50.0	1

TABLE 264.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	48.3	20.7	27.6	3.4	3.4	29
N+1	27.3	31.8	31.8	9.1	12.2	22
N+2	44.4	22.2	33.3	0.0	12.2	18
N+3	50.0	0.0	50.0	0.0	12.2	6
N+4	50.0	0.0	25.0	25.0	34.2	4
N+5	50.0	0.0	50.0	0.0	34.2	2
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	6.7	30.0	56.7	6.7	6.7	30
N+1	0.0	20.0	35.0	45.0	48.7	20
N+2	0.0	14.3	42.9	42.9	70.7	7
N+3	0.0	100.0	0.0	0.0	70.7	1
N+4	0.0	0.0	0.0	0.0	70.7	0
N+5	0.0	0.0	0.0	0.0	70.7	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.7	88.9	7.4	7.4	27
N+1	0.0	0.0	62.5	37.5	42.1	16
N+2	0.0	0.0	33.3	66.7	80.7	3
N+3	0.0	0.0	0.0	0.0	80.7	0
N+4	0.0	0.0	0.0	0.0	80.7	0
N+5	0.0	0.0	0.0	0.0	80.7	0

TABLE 265.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	91.0	6.9	1.6	0.5	0.5	189
N+1	88.0	7.6	3.8	0.6	1.2	158
N+2	85.6	10.1	3.6	0.7	1.9	139
N+3	82.1	13.8	4.1	0.0	1.9	123
N+4	78.4	14.4	7.2	0.0	1.9	97
N+5	77.2	13.9	8.9	0.0	1.9	79
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	16.4	67.2	15.6	0.8	0.8	128
N+1	20.0	61.0	16.2	2.9	3.6	105
N+2	20.7	58.5	19.5	1.2	4.8	82
N+3	22.1	51.9	26.0	0.0	4.8	77
N+4	26.9	49.3	22.4	1.5	6.2	67
N+5	29.4	41.2	29.4	0.0	6.2	51
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.5	6.9	88.2	3.4	3.4	204
N+1	1.7	12.4	79.8	6.2	9.4	178
N+2	2.3	19.8	76.3	1.5	10.8	131
N+3	6.1	20.0	73.9	0.0	10.8	115
N+4	8.2	21.6	68.0	2.1	12.6	97
N+5	9.0	26.9	64.2	0.0	12.6	67

TABLE 266.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.8	41.0	8.2	0.0	0.0	61
N+1	58.8	29.4	7.8	3.9	3.9	51
N+2	65.8	23.7	5.3	5.3	9.0	38
N+3	31.8	54.5	13.6	0.0	9.0	22
N+4	55.6	38.9	5.6	0.0	9.0	18
N+5	46.7	46.7	6.7	0.0	9.0	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.9	44.4	46.7	0.0	0.0	45
N+1	6.5	29.0	48.4	16.1	16.1	31
N+2	5.3	36.8	52.6	5.3	20.5	19
N+3	14.3	28.6	57.1	0.0	20.5	7
N+4	16.7	16.7	66.7	0.0	20.5	6
N+5	0.0	20.0	80.0	0.0	20.5	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	11.5	80.8	7.7	7.7	26
N+1	0.0	7.1	64.3	28.6	34.1	14
N+2	0.0	12.5	62.5	25.0	50.5	8
N+3	0.0	40.0	60.0	0.0	50.5	5
N+4	0.0	25.0	75.0	0.0	50.5	4
N+5	0.0	0.0	100.0	0.0	50.5	3

TABLE 267.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.5	34.8	8.7	0.0	0.0	23
N+1	50.0	40.0	10.0	0.0	0.0	20
N+2	61.1	27.8	5.6	5.6	5.6	18
N+3	60.0	40.0	0.0	0.0	5.6	10
N+4	50.0	50.0	0.0	0.0	5.6	8
N+5	37.5	62.5	0.0	0.0	5.6	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	47.8	52.2	0.0	0.0	23
N+1	0.0	43.8	43.8	12.5	12.5	16
N+2	9.1	27.3	54.5	9.1	20.5	11
N+3	14.3	28.6	57.1	0.0	20.5	7
N+4	16.7	33.3	50.0	0.0	20.5	6
N+5	0.0	25.0	75.0	0.0	20.5	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	7.1	92.9	0.0	0.0	14
N+1	0.0	0.0	100.0	0.0	0.0	7
N+2	0.0	0.0	83.3	16.7	16.7	6
N+3	0.0	50.0	50.0	0.0	16.7	4
N+4	0.0	33.3	66.7	0.0	16.7	3
N+5	0.0	0.0	100.0	0.0	16.7	2

TABLE 268.

MIXED OAKS * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	87.0	13.0	0.0	0.0	0.0	23
N+1	77.3	13.6	9.1	0.0	0.0	22
N+2	68.8	18.8	12.5	0.0	0.0	16
N+3	66.7	33.3	0.0	0.0	0.0	15
N+4	60.0	40.0	0.0	0.0	0.0	15
N+5	50.0	50.0	0.0	0.0	0.0	12
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	5.0	85.0	10.0	0.0	0.0	20
N+1	10.0	75.0	10.0	5.0	5.0	20
N+2	11.1	72.2	11.1	5.6	10.3	18
N+3	11.8	82.4	5.9	0.0	10.3	17
N+4	11.8	82.4	5.9	0.0	10.3	17
N+5	10.0	80.0	10.0	0.0	10.3	10
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	11.1	88.9	0.0	0.0	18
N+1	0.0	25.0	75.0	0.0	0.0	16
N+2	0.0	26.7	73.3	0.0	0.0	15
N+3	0.0	26.7	73.3	0.0	0.0	15
N+4	13.3	26.7	60.0	0.0	0.0	15
N+5	0.0	25.0	75.0	0.0	0.0	8

TABLE 269.

FOOD CLASS B

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	63.6	27.2	8.8	0.3	0.3	86O
N+1	68.4	17.7	8.9	5.0	5.3	7O5
N+2	68.2	18.0	9.3	4.4	9.5	61O
N+3	63.7	17.3	16.9	2.1	11.4	526
N+4	64.8	19.0	14.0	2.3	13.4	48O
N+5	63.2	19.7	14.8	2.3	15.4	427
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.4	49.1	35.6	0.9	0.9	32O
N+1	12.8	41.1	31.5	14.6	15.4	21S
N+2	15.7	39.6	34.0	10.7	24.5	15S
N+3	14.0	33.1	43.8	9.1	31.3	121
N+4	11.7	36.2	48.9	3.2	33.5	S4
N+5	23.0	26.4	43.7	6.9	38.1	87
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.3	4.0	93.3	1.3	1.3	15O
N+1	2.7	5.5	43.6	48.2	48.9	11O
N+2	2.1	4.3	74.5	19.1	58.7	47
N+3	3.1	9.4	71.9	15.6	65.1	32
N+4	8.3	4.2	79.2	8.3	68.0	24
N+5	9.1	9.1	81.8	0.0	68.0	22

TABLE 270.

FOOD CLASS B

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	40.2	43.3	15.7	0.8	0.8	127
N+1	56.5	23.9	12.0	7.6	8.3	92
N+2	61.2	20.0	13.7	5.0	12.9	80
N+3	59.4	14.5	24.6	1.4	14.2	69
N+4	47.7	26.2	23.1	3.1	16.8	65
N+5	41.0	29.5	26.2	3.3	19.5	61
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	2.4	28.0	67.1	2.4	2.4	82
N+1	2.1	27.7	31.9	38.3	39.8	47
N+2	7.7	23.1	53.8	15.4	49.1	26
N+3	15.8	10.5	52.6	21.1	59.8	19
N+4	7.7	38.5	53.8	0.0	59.8	13
N+5	7.7	30.8	61.5	0.0	59.8	13
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	20
N+1	0.0	10.0	70.0	20.0	20.0	10
N+2	0.0	0.0	85.7	14.3	31.4	7
N+3	0.0	0.0	100.0	0.0	31.4	5
N+4	0.0	0.0	100.0	0.0	31.4	5
N+5	0.0	0.0	100.0	0.0	31.4	5

TABLE 271.

FOOD CLASS 8

DEFOLIATION HISTORY--HHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	37.0	22.2	37.0	3.7	3.7	27
N+1	18.8	18.8	43.8	18.8	21.8	16
N+2	20.0	30.0	40.0	10.0	29.6	10
N+3	50.0	0.0	0.0	50.0	64.8	4
N+4	100.0	0.0	0.0	0.0	64.8	1
N+5	100.0	0.0	0.0	0.0	64.8	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.8	11.1	66.7	7.4	7.4	27
N+1	5.9	11.8	41.2	41.2	45.5	17
N+2	10.0	0.0	90.0	0.0	45.5	10
N+3	0.0	12.5	75.0	12.5	52.3	8
N+4	0.0	0.0	85.7	14.3	59.2	7
N+5	0.0	0.0	100.0	0.0	59.2	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	75.0	25.0	25.0	4
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 272.

FOOD CLASS B

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	72.3	18.6	9.1	0.0	0.0	581
N+1	65.5	18.7	11.8	4.1	4.1	466
N+2	63.3	20.0	13.0	3.6	7.6	414
N+3	65.2	17.6	15.2	2.1	9.5	330
N+4	61.9	21.5	15.1	1.5	10.9	265
N+5	60.3	21.8	16.2	1.7	12.4	234
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.2	59.4	31.2	1.2	1.2	170
N+1	9.4	45.3	35.0	10.3	11.3	117
N+2	8.1	43.0	40.7	8.1	18.5	86
N+3	4.7	42.2	45.3	7.8	24.9	64
N+4	2.0	36.7	59.2	2.0	26.4	49
N+5	9.8	26.8	58.5	4.9	30.0	41
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	3.2	91.6	5.3	5.3	95
N+1	1.4	2.9	54.3	41.4	44.5	70
N+2	0.0	3.2	71.0	25.8	58.8	31
N+3	0.0	10.0	75.0	15.0	65.0	20
N+4	0.0	7.7	84.6	7.7	67.7	13
N+5	0.0	10.0	90.0	0.0	67.7	10

TABLE 273.

FCCD CLASS B

DEFCLIATICN HISTCRY--HLH

YEAR	GCCD	FAIR	PCCR	CEAC	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCCD CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	33.3	44.4	16.7	5.6	5.6	36
N+1	42.9	35.7	14.3	7.1	12.3	14
N+2	75.0	0.0	12.5	12.5	23.3	8
N+3	85.7	0.0	14.3	0.0	23.3	7
N+4	80.0	0.0	0.0	20.0	38.6	5
N+5	100.0	0.0	0.0	0.0	38.6	4
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	7.1	35.7	50.0	7.1	7.1	14
N+1	0.0	55.6	33.3	11.1	17.5	9
N+2	0.0	25.0	75.0	0.0	17.5	4
N+3	25.0	50.0	25.0	0.0	17.5	4
N+4	50.0	0.0	50.0	0.0	17.5	2
N+5	50.0	0.0	50.0	0.0	17.5	2
PCCR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	2
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 274.

FOOD CLASS 8

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	34.2	50.0	12.3	3.5	3.5	114
N+1	68.5	19.6	8.7	3.3	6.7	92
N+2	68.4	17.1	10.5	3.9	10.3	76
N+3	64.2	14.9	20.9	0.0	10.3	67
N+4	47.2	32.1	18.9	1.9	12.0	53
N+5	42.3	32.7	21.2	3.8	15.4	52
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	36.1	52.5	11.5	11.5	61
N+1	6.3	34.4	31.3	28.1	36.4	32
N+2	10.5	26.3	42.1	21.1	49.8	19
N+3	15.4	15.4	53.8	15.4	57.5	13
N+4	0.0	50.0	50.0	0.0	57.5	8
N+5	0.0	37.5	62.5	0.0	57.5	8
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	75.0	25.0	25.0	16
N+1	0.0	0.0	87.5	12.5	34.4	8
N+2	0.0	0.0	85.7	14.3	43.7	7
N+3	0.0	0.0	100.0	0.0	43.7	4
N+4	0.0	0.0	100.0	0.0	43.7	2
N+5	0.0	0.0	100.0	0.0	43.7	2

TABLE 275.

FOOD CLASS B

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.2	4.3	1.4	0.1	0.1	7345
N+1	90.8	6.5	2.4	0.3	0.4	6930
N+2	85.8	8.8	4.8	0.6	1.0	6444
N+3	84.2	9.7	5.5	0.6	1.6	5998
N+4	82.5	10.9	6.1	0.4	2.0	5604
N+5	79.2	12.3	8.1	0.4	2.4	5071
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	18.6	70.6	9.9	0.9	0.9	1945
N+1	27.1	56.3	14.7	1.9	2.8	1737
N+2	30.2	47.7	20.1	2.0	4.8	1573
N+3	30.1	46.4	21.5	1.9	6.6	1411
N+4	31.1	44.0	22.5	2.3	8.8	1279
N+5	36.1	39.6	22.6	1.7	10.4	1055
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.4	6.8	82.6	9.2	9.2	1326
N+1	3.4	12.9	74.7	9.0	17.4	1030
N+2	5.2	18.4	68.8	7.7	23.8	832
N+3	7.3	20.1	70.2	2.4	25.6	667
N+4	9.3	25.2	62.1	3.4	28.1	580
N+5	12.9	29.3	53.3	4.5	31.4	443

TABLE 276.

FCCD CLASS B * DCMINANT * DIAMETER CLASS 1

DEFCLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NC.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	86.4	8.8	4.8	0.0	0.0	294
N+1	83.3	8.0	4.7	4.0	4.0	275
N+2	81.4	9.3	3.7	5.6	9.4	215
N+3	81.9	10.1	6.5	1.4	10.7	138
N+4	80.5	7.8	7.8	3.9	14.2	128
N+5	72.2	13.9	12.5	1.4	15.4	72
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	12.5	58.3	25.0	4.2	4.2	24
N+1	4.8	28.6	23.8	42.9	45.2	21
N+2	8.3	41.7	33.3	16.7	54.4	12
N+3	0.0	57.1	42.9	0.0	54.4	7
N+4	14.3	28.6	57.1	0.0	54.4	7
N+5	20.0	20.0	60.0	0.0	54.4	5
PCCR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	6.3	87.5	6.3	6.3	16
N+1	0.0	12.5	25.0	62.5	64.8	8
N+2	0.0	0.0	50.0	50.0	82.4	2
N+3	0.0	0.0	100.0	0.0	82.4	1
N+4	0.0	0.0	0.0	100.0	100.0	1
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 277.

FOOD CLASS 8 * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	86.1	8.4	4.8	0.6	0.6	166
N+1	81.9	6.0	6.7	5.4	5.9	149
N+2	82.9	9.5	3.8	3.8	9.5	105
N+3	86.5	5.8	7.7	0.0	9.5	52
N+4	82.2	8.9	8.9	0.0	9.5	45
N+5	76.7	11.6	11.6	0.0	9.5	43
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	8.3	58.3	33.3	0.0	0.0	12
N+1	8.3	25.0	25.0	41.7	41.7	12
N+2	14.3	57.1	28.6	0.0	41.7	7
N+3	0.0	60.0	40.0	0.0	41.7	5
N+4	0.0	40.0	60.0	0.0	41.7	5
N+5	0.0	33.3	66.7	0.0	41.7	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	83.3	16.7	16.7	12
N+1	0.0	0.0	25.0	75.0	79.2	4
N+2	0.0	0.0	100.0	0.0	79.2	1
N+3	0.0	0.0	100.0	0.0	79.2	1
N+4	0.0	0.0	0.0	100.0	100.0	1
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 278.

FCCD CLASS B * DCMINANT * DIAMETER CLASS 1

DEFCLIATION HISTORY--LLLLL

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	97.1	2.2	0.7	0.0	0.0	907
N+1	95.0	3.5	1.3	0.2	0.2	858
N+2	86.5	7.3	5.7	0.5	0.7	805
N+3	85.8	7.1	6.6	0.5	1.2	763
N+4	84.7	7.0	8.1	0.1	1.4	727
N+5	76.4	11.4	11.4	0.8	2.1	666
FAIR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	22.1	67.3	9.7	0.9	0.9	113
N+1	28.6	43.8	25.7	1.9	2.8	105
N+2	34.4	33.3	30.2	2.1	4.8	96
N+3	35.6	37.8	24.4	2.2	6.9	90
N+4	40.2	28.0	29.3	2.4	9.2	82
N+5	58.5	20.8	20.8	0.0	9.2	53
POCR CONDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	2.0	3.0	88.1	6.9	6.9	101
N+1	3.7	7.3	75.6	13.4	19.4	82
N+2	1.6	29.7	60.9	7.8	25.7	64
N+3	1.9	35.2	61.1	1.9	27.1	54
N+4	2.1	35.4	58.3	4.2	30.1	48
N+5	10.7	57.1	28.6	3.6	32.6	28

TABLE 279.

FCOD CLASS B * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	CEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NC.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	80.0	15.8	3.9	0.2	0.2	411
N+1	80.0	11.2	5.1	3.7	4.0	375
N+2	73.8	13.5	8.7	4.0	7.8	275
N+3	65.6	16.0	17.0	1.4	9.1	212
N+4	63.5	18.2	14.8	3.4	12.2	203
N+5	67.6	17.0	13.6	1.7	13.7	176
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	15.9	55.6	23.8	4.8	4.8	63
N+1	31.1	31.1	13.3	24.4	28.0	45
N+2	31.0	27.6	20.7	20.7	42.9	29
N+3	25.0	30.0	45.0	0.0	42.9	20
N+4	23.5	29.4	35.3	11.8	49.6	17
N+5	33.3	20.0	33.3	13.3	56.4	15
POCR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	3.0	0.0	93.9	3.0	3.0	33
N+1	4.3	0.0	39.1	56.5	57.8	23
N+2	12.5	0.0	62.5	25.0	68.4	8
N+3	25.0	0.0	75.0	0.0	68.4	4
N+4	25.0	0.0	75.0	0.0	68.4	4
N+5	25.0	0.0	75.0	0.0	68.4	4

TABLE 280.

FCOD CLASS 8 * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOCD	FAIR	PCOR	CEAD	CUM. CEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	50.0	41.2	8.8	0.0	0.0	34
N+1	75.9	10.3	3.4	10.3	10.3	29
N+2	77.8	16.7	5.6	0.0	10.3	18
N+3	77.8	5.6	16.7	0.0	10.3	18
N+4	55.6	22.2	22.2	0.0	10.3	18
N+5	50.0	33.3	16.7	0.0	10.3	18
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	9.1	36.4	54.5	0.0	0.0	11
N+1	25.0	0.0	25.0	50.0	50.0	8
N+2	0.0	0.0	100.0	0.0	50.0	2
N+3	0.0	0.0	100.0	0.0	50.0	2
N+4	0.0	0.0	100.0	0.0	50.0	2
N+5	0.0	0.0	100.0	0.0	50.0	2
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	100.0	0.0	50.0	1
N+3	0.0	0.0	100.0	0.0	50.0	1
N+4	0.0	0.0	100.0	0.0	50.0	1
N+5	0.0	0.0	100.0	0.0	50.0	1

TABLE 281.

FCOD CLASS B * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	82.2	10.3	7.1	0.4	0.4	253
N+1	74.8	13.3	8.0	4.0	4.4	226
N+2	66.7	17.4	13.3	2.6	6.8	195
N+3	62.3	20.5	15.8	1.4	8.1	146
N+4	61.5	22.3	13.8	2.3	10.2	130
N+5	70.4	15.7	12.2	1.7	11.8	115
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	14.7	52.9	32.4	0.0	0.0	34
N+1	34.5	24.1	24.1	17.2	17.2	29
N+2	27.3	27.3	18.2	27.3	39.8	22
N+3	16.7	25.0	58.3	0.0	39.8	12
N+4	22.2	22.2	33.3	22.2	53.2	9
N+5	33.3	16.7	33.3	16.7	61.0	6
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	28
N+1	0.0	0.0	47.4	52.6	52.6	19
N+2	0.0	0.0	66.7	33.3	68.4	6
N+3	0.0	0.0	100.0	0.0	68.4	2
N+4	0.0	0.0	100.0	0.0	68.4	2
N+5	0.0	0.0	100.0	0.0	68.4	2

TABLE 282.

FCCD CLASS B * DCMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	56.8	35.1	2.7	5.4	5.4	37
N+1	77.8	11.1	11.1	0.0	5.4	18
N+2	75.0	12.5	6.3	6.3	11.3	16
N+3	21.4	28.6	50.0	0.0	11.3	14
N+4	15.4	30.8	46.2	7.7	18.1	13
N+5	16.7	33.3	50.0	0.0	18.1	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	25.0	75.0	0.0	0.0	0.0	4
N+1	0.0	100.0	0.0	0.0	0.0	3
N+2	0.0	66.7	33.3	0.0	0.0	3
N+3	0.0	66.7	33.3	0.0	0.0	3
N+4	0.0	33.3	66.7	0.0	0.0	3
N+5	0.0	33.3	66.7	0.0	0.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 283.

FCOD CLASS B * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LPH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	31.4	54.3	8.6	5.7	5.7	35
N+1	82.8	6.9	3.4	6.9	12.2	29
N+2	78.9	15.8	5.3	0.0	12.2	19
N+3	73.7	10.5	15.8	0.0	12.2	19
N+4	50.0	33.3	16.7	0.0	12.2	12
N+5	50.0	41.7	8.3	0.0	12.2	12
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.5	50.0	37.5	0.0	0.0	8
N+1	40.0	0.0	0.0	60.0	60.0	5
N+2	0.0	0.0	0.0	0.0	60.0	0
N+3	0.0	0.0	0.0	0.0	60.0	0
N+4	0.0	0.0	0.0	0.0	60.0	0
N+5	0.0	0.0	0.0	0.0	60.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	66.7	33.3	33.3	3
N+2	0.0	0.0	100.0	0.0	33.3	2
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	100.0	0.0	33.3	1
N+5	0.0	0.0	100.0	0.0	33.3	1

TABLE 284.

FCOD CLASS B * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	95.3	3.3	1.3	0.1	0.1	2723
N+1	93.0	4.2	2.7	0.2	0.3	2527
N+2	86.7	7.1	5.7	0.6	0.8	2354
N+3	85.4	7.6	6.7	0.3	1.1	2197
N+4	84.6	8.1	7.1	0.2	1.4	2038
N+5	80.1	10.3	9.3	0.3	1.7	1854
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.5	66.8	13.2	0.5	0.5	394
N+1	30.1	48.9	18.5	2.5	3.0	356
N+2	40.2	34.6	22.7	2.5	5.4	321
N+3	41.4	32.1	24.8	1.7	7.1	290
N+4	46.4	26.2	23.8	3.6	10.4	252
N+5	52.5	25.2	19.8	2.5	12.6	202
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.9	3.7	88.5	6.9	6.9	347
N+1	3.0	10.2	77.8	9.0	15.3	266
N+2	11.7	20.3	57.7	10.4	24.1	222
N+3	15.5	25.9	58.0	0.6	24.5	174
N+4	18.7	28.5	49.6	3.3	27.0	123
N+5	30.6	27.6	32.7	9.2	33.7	98

TABLE 285.

FOOD CLASS B * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	79.5	15.8	4.2	0.4	0.4	448
N+1	78.1	12.0	3.9	6.0	6.4	383
N+2	69.7	15.3	5.7	9.3	15.2	300
N+3	67.6	18.8	9.9	3.8	18.3	213
N+4	66.1	18.3	8.6	7.0	24.1	186
N+5	65.9	19.0	12.7	2.4	25.9	126
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	22.7	46.4	27.8	3.1	3.1	97
N+1	22.4	37.9	17.2	22.4	24.8	58
N+2	27.8	36.1	30.6	5.6	29.0	36
N+3	14.3	42.9	28.6	14.3	39.1	28
N+4	5.3	52.6	42.1	0.0	39.1	19
N+5	27.8	22.2	44.4	5.6	42.5	18
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.1	3.0	81.8	3.0	3.0	33
N+1	12.5	0.0	41.7	45.8	47.5	24
N+2	12.5	0.0	62.5	25.0	60.6	8
N+3	0.0	0.0	100.0	0.0	60.6	5
N+4	0.0	0.0	80.0	20.0	68.5	5
N+5	0.0	0.0	100.0	0.0	68.5	4

TABLE 286.

FCOD CLASS B * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.2	38.5	13.5	3.8	3.8	52
N+1	65.7	17.1	5.7	11.4	14.8	35
N+2	65.2	8.7	13.0	13.0	25.9	23
N+3	57.9	15.8	21.1	5.3	29.8	19
N+4	50.0	18.8	25.0	6.3	34.2	16
N+5	42.9	28.6	21.4	7.1	38.9	14
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	7.1	35.7	57.1	0.0	0.0	28
N+1	10.5	21.1	26.3	42.1	42.1	19
N+2	28.6	14.3	57.1	0.0	42.1	7
N+3	28.6	14.3	42.9	14.3	50.4	7
N+4	0.0	60.0	40.0	0.0	50.4	5
N+5	0.0	40.0	60.0	0.0	50.4	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	100.0	0.0	0.0	3
N+2	0.0	0.0	100.0	0.0	0.0	2
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 287.

FOOD CLASS B * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	82.4	12.8	4.8	0.0	0.0	227
N+1	82.1	10.5	3.7	3.7	3.7	190
N+2	74.4	15.2	5.5	4.9	8.4	164
N+3	73.6	18.9	6.6	0.9	9.2	106
N+4	71.1	21.7	6.0	1.2	10.3	83
N+5	65.4	20.5	12.8	1.3	11.5	78
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	23.1	55.8	21.2	0.0	0.0	52
N+1	33.3	33.3	21.2	12.1	12.1	33
N+2	16.7	41.7	33.3	8.3	19.4	24
N+3	0.0	53.3	26.7	20.0	35.6	15
N+4	0.0	63.6	36.4	0.0	35.6	11
N+5	40.0	10.0	50.0	0.0	35.6	10
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	19.0	9.5	61.9	9.5	9.5	21
N+1	15.4	0.0	38.5	46.2	51.3	13
N+2	20.0	0.0	40.0	40.0	70.8	5
N+3	0.0	0.0	100.0	0.0	70.8	3
N+4	0.0	0.0	100.0	0.0	70.8	2
N+5	0.0	0.0	100.0	0.0	70.8	1

TABLE 288.

FCCD CLASS B * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	57.7	23.1	11.5	7.7	7.7	26
N+1	50.0	40.0	0.0	10.0	16.9	10
N+2	100.0	0.0	0.0	0.0	16.9	6
N+3	83.3	16.7	0.0	0.0	16.9	6
N+4	25.0	25.0	0.0	50.0	58.5	4
N+5	100.0	0.0	0.0	0.0	58.5	1
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	66.7	33.3	0.0	0.0	3
N+1	0.0	33.3	66.7	0.0	0.0	3
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	100.0	0.0	0.0	0.0	1
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	1
N+1	0.0	100.0	0.0	0.0	0.0	1
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	0.0	1
N+5	0.0	0.0	100.0	0.0	0.0	1

TABLE 289.

FCCD CLASS B * INTERMECIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	42.5	42.5	7.5	7.5	7.5	4C
N+1	75.9	13.8	3.4	6.9	13.9	29
N+2	73.7	5.3	5.3	15.8	27.5	19
N+3	66.7	13.3	13.3	6.7	32.3	15
N+4	58.3	25.0	16.7	0.0	32.3	12
N+5	50.0	33.3	8.3	8.3	38.0	12
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	52.9	41.2	5.9	5.9	17
N+1	16.7	25.0	25.0	33.3	37.3	12
N+2	40.0	20.0	40.0	0.0	37.3	5
N+3	40.0	20.0	40.0	0.0	37.3	5
N+4	0.0	75.0	25.0	0.0	37.3	4
N+5	0.0	50.0	50.0	0.0	37.3	4
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	3
N+1	0.0	0.0	100.0	0.0	0.0	2
N+2	0.0	0.0	100.0	0.0	0.0	1
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 290.

FCCD CLASS B * INTERMECIATE * CIAMETER CLASS 1

CEFCLIATION HISTORY--LLLLL

YEAR	GOCC	FAIR	PCOR	CEAC	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.9	5.7	1.2	0.3	0.3	1451
N+1	88.6	8.2	2.7	0.5	0.8	134C
N+2	82.1	12.2	5.2	0.5	1.3	1222
N+3	79.2	13.8	6.4	0.6	1.9	1143
N+4	77.1	15.0	7.1	0.8	2.6	1C53
N+5	72.8	16.8	9.9	0.5	3.1	944
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.0	68.4	11.2	1.4	1.4	421
N+1	24.7	55.8	16.7	2.8	4.2	389
N+2	29.1	44.9	22.6	3.4	7.5	35C
N+3	32.9	40.3	22.9	3.9	11.1	31C
N+4	30.4	44.1	22.6	3.0	13.7	27C
N+5	35.1	41.7	20.6	2.6	16.0	228
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.8	4.1	83.7	11.4	11.4	246
N+1	2.2	10.1	75.3	12.4	22.3	178
N+2	3.7	15.6	68.9	11.9	31.5	135
N+3	6.5	17.8	72.9	2.8	33.5	107
N+4	10.8	19.3	66.3	3.6	35.9	83
N+5	11.9	23.7	55.9	8.5	41.3	59

TABLE 291.

FCOD CLASS 8 * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	69.3	24.3	6.3	0.0	0.0	189
N+1	75.0	16.9	2.5	5.6	5.6	160
N+2	68.3	23.3	5.0	3.3	8.8	120
N+3	58.1	17.2	23.7	1.1	9.8	93
N+4	58.4	15.7	24.7	1.1	10.8	89
N+5	55.0	15.0	28.7	1.2	11.9	80
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	15.6	62.2	22.2	0.0	0.0	45
N+1	30.0	36.7	26.7	6.7	6.7	30
N+2	13.3	33.3	40.0	13.3	19.1	15
N+3	0.0	20.0	60.0	20.0	35.3	10
N+4	0.0	14.3	71.4	14.3	44.5	7
N+5	0.0	20.0	60.0	20.0	55.6	5
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	92.9	7.1	7.1	14
N+1	10.0	0.0	20.0	70.0	72.1	10
N+2	0.0	0.0	50.0	50.0	86.1	2
N+3	0.0	0.0	0.0	100.0	100.0	1
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 292.

FCOD CLASS B * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HH

YEAR	GOCD	FAIR	PCOR	CEAC	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	51.9	40.7	7.4	0.0	0.0	27
N+1	76.2	14.3	4.8	4.8	4.8	21
N+2	70.0	20.0	10.0	0.0	4.8	1C
N+3	50.0	12.5	37.5	0.0	4.8	8
N+4	37.5	25.0	37.5	0.0	4.8	8
N+5	37.5	12.5	50.0	0.0	4.8	8
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	60.0	40.0	0.0	0.0	1C
N+1	28.6	28.6	14.3	28.6	28.6	7
N+2	0.0	50.0	50.0	0.0	28.6	2
N+3	0.0	0.0	100.0	0.0	28.6	2
N+4	0.0	0.0	100.0	0.0	28.6	2
N+5	0.0	0.0	100.0	0.0	28.6	2
POOR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 293.

FOOD CLASS B * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	80.4	8.8	10.8	0.0	0.0	102
N+1	73.3	16.3	4.7	5.8	5.8	86
N+2	71.6	18.9	6.8	2.7	8.4	74
N+3	70.2	15.8	12.3	1.8	10.0	57
N+4	68.2	15.9	15.9	0.0	10.0	44
N+5	61.5	17.9	17.9	2.6	12.3	39
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	13.6	63.6	22.7	0.0	0.0	22
N+1	33.3	20.0	40.0	6.7	6.7	15
N+2	0.0	37.5	50.0	12.5	18.3	8
N+3	0.0	33.3	50.0	16.7	31.9	6
N+4	0.0	20.0	60.0	20.0	45.6	5
N+5	0.0	33.3	66.7	0.0	45.6	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	8
N+1	14.3	0.0	14.3	71.4	71.4	7
N+2	0.0	0.0	100.0	0.0	71.4	1
N+3	0.0	0.0	0.0	100.0	100.0	1
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 294.

FCOD CLASS B * INTERMECIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOCD	FAIR	PLOR	CEAC	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCCD CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	57.1	35.7	7.1	0.0	C.0	28
N+1	50.0	50.0	0.0	0.0	0.0	1C
N+2	33.3	44.4	22.2	0.0	C.C	9
N+3	12.5	12.5	75.0	0.0	0.0	8
N+4	12.5	12.5	75.0	0.0	0.0	8
N+5	12.5	12.5	75.0	0.0	0.0	8
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	40.0	50.0	10.0	0.0	0.0	1C
N+1	30.0	50.0	10.0	10.0	10.0	1C
N+2	28.6	42.9	14.3	14.3	22.9	7
N+3	0.0	33.3	66.7	0.0	22.9	6
N+4	0.0	33.3	66.7	0.0	22.9	6
N+5	0.0	50.0	50.0	0.0	22.9	4
PCCR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	C
N+1	0.0	0.0	0.0	0.0	0.0	C
N+2	0.0	0.0	0.0	0.0	C.C	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	C.0	0.0	0.0	C.0	C

TABLE 295.

FOOD CLASS B * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.0	42.9	3.6	3.6	3.6	28
N+1	77.3	18.2	0.0	4.5	8.0	22
N+2	75.0	16.7	8.3	0.0	8.0	12
N+3	60.0	10.0	30.0	0.0	8.0	10
N+4	37.5	25.0	37.5	0.0	8.0	8
N+5	37.5	12.5	50.0	0.0	8.0	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	70.0	30.0	0.0	0.0	10
N+1	25.0	25.0	25.0	25.0	25.0	8
N+2	0.0	50.0	50.0	0.0	25.0	2
N+3	0.0	0.0	100.0	0.0	25.0	2
N+4	0.0	0.0	100.0	0.0	25.0	2
N+5	0.0	0.0	100.0	0.0	25.0	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	100.0	0.0	0.0	1
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 296.

FOOD CLASS B * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	91.4	5.1	3.1	0.3	0.3	1146
N+1	89.8	6.2	3.1	0.9	1.2	1048
N+2	85.4	8.4	4.8	1.3	2.5	975
N+3	83.0	10.6	5.6	0.8	3.3	894
N+4	82.0	11.5	5.8	0.7	4.0	834
N+5	80.1	13.5	6.0	0.4	4.4	770
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	15.6	71.4	10.7	2.3	2.3	262
N+1	30.8	53.1	12.9	3.1	5.3	224
N+2	40.1	40.6	16.2	3.0	8.2	197
N+3	34.5	43.5	20.2	1.8	9.9	168
N+4	38.4	37.0	22.6	2.1	11.7	146
N+5	43.5	28.2	25.0	3.2	14.6	124
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	7.0	81.7	11.3	11.3	186
N+1	2.9	16.7	71.0	9.4	19.6	138
N+2	6.3	22.3	67.0	4.5	23.2	112
N+3	6.8	23.3	66.0	3.9	26.2	103
N+4	7.4	33.0	55.3	4.3	29.4	94
N+5	15.9	23.2	58.0	2.9	31.4	69

TABLE 297.

FOOD CLASS B * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	64.4	25.4	9.1	1.2	1.2	331
N+1	63.0	17.7	9.8	9.4	10.5	265
N+2	63.3	20.5	11.6	4.7	14.7	215
N+3	57.8	21.7	17.2	3.3	17.5	180
N+4	64.7	22.4	10.3	2.6	19.6	156
N+5	65.7	21.0	12.6	0.7	20.2	143
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	12.9	47.8	38.8	0.6	0.6	178
N+1	16.7	37.1	32.6	13.6	14.1	132
N+2	17.3	37.8	29.6	15.3	27.3	98
N+3	14.3	33.3	42.9	9.5	34.2	63
N+4	12.5	39.6	45.8	2.1	35.6	48
N+5	22.7	27.3	47.7	2.3	37.0	44
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	1.2	5.8	91.9	1.2	1.2	86
N+1	1.6	8.1	43.5	46.8	47.4	62
N+2	0.0	7.1	67.9	25.0	60.5	28
N+3	0.0	16.7	61.1	22.2	69.3	18
N+4	8.3	8.3	83.3	0.0	69.3	12
N+5	8.3	8.3	83.3	0.0	69.3	12

TABLE 298.

FOOD CLASS B * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--HH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	33.3	35.6	24.4	6.7	6.7	45
N+1	35.3	32.4	17.6	14.7	20.4	34
N+2	42.3	30.8	19.2	7.7	26.5	26
N+3	47.4	21.1	26.3	5.3	30.4	19
N+4	50.0	27.8	16.7	5.6	34.3	18
N+5	37.5	37.5	25.0	0.0	34.3	16
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.6	69.2	5.1	5.1	39
N+1	0.0	33.3	28.6	38.1	41.3	21
N+2	0.0	25.0	41.7	33.3	60.8	12
N+3	0.0	16.7	33.3	50.0	80.4	6
N+4	0.0	50.0	50.0	0.0	80.4	2
N+5	0.0	50.0	50.0	0.0	80.4	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	14
N+1	0.0	16.7	66.7	16.7	16.7	6
N+2	0.0	0.0	75.0	25.0	37.5	4
N+3	0.0	0.0	100.0	0.0	37.5	3
N+4	0.0	0.0	100.0	0.0	37.5	3
N+5	0.0	0.0	100.0	0.0	37.5	3

TABLE 299.

FCOD CLASS B * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	70.4	23.8	5.8	0.0	0.0	206
N+1	65.6	18.5	10.2	5.7	5.7	157
N+2	65.7	18.7	13.4	2.2	7.8	134
N+3	67.0	15.6	14.7	2.8	10.4	109
N+4	62.2	23.2	12.2	2.4	12.6	82
N+5	59.7	25.0	15.3	0.0	12.6	72
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.7	53.4	34.0	1.9	1.9	103
N+1	14.9	45.9	29.7	9.5	11.2	74
N+2	17.9	37.5	35.7	8.9	19.1	56
N+3	8.1	43.2	43.2	5.4	23.5	37
N+4	3.7	33.3	63.0	0.0	23.5	27
N+5	0.0	26.1	69.6	4.3	26.8	23
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	6.1	87.8	6.1	6.1	49
N+1	0.0	8.3	61.1	30.6	34.8	36
N+2	0.0	5.6	61.1	33.3	56.5	18
N+3	0.0	20.0	60.0	20.0	65.2	10
N+4	0.0	14.3	85.7	0.0	65.2	7
N+5	0.0	16.7	83.3	0.0	65.2	6

TABLE 300.

FOOD CLASS B * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LHH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	36.6	31.7	22.0	9.8	9.8	41
N+1	57.1	28.6	11.4	2.9	12.3	35
N+2	56.5	26.1	13.0	4.3	16.1	23
N+3	55.6	22.2	22.2	0.0	16.1	18
N+4	50.0	31.3	12.5	6.3	21.4	16
N+5	40.0	40.0	20.0	0.0	21.4	15
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	23.5	58.8	17.6	17.6	34
N+1	0.0	43.8	31.3	25.0	38.2	16
N+2	0.0	27.3	36.4	36.4	60.7	11
N+3	0.0	16.7	50.0	33.3	73.8	6
N+4	0.0	50.0	50.0	0.0	73.8	2
N+5	0.0	50.0	50.0	0.0	73.8	2
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	63.6	36.4	36.4	11
N+1	0.0	0.0	100.0	0.0	36.4	4
N+2	0.0	0.0	75.0	25.0	52.3	4
N+3	0.0	0.0	100.0	0.0	52.3	3
N+4	0.0	0.0	100.0	0.0	52.3	1
N+5	0.0	0.0	100.0	0.0	52.3	1

TABLE 301.

FCOD CLASS B * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.1	4.9	0.9	0.1	0.1	1726
N+1	89.4	8.1	2.0	0.4	0.5	1620
N+2	86.1	9.4	4.1	0.3	0.9	1515
N+3	85.2	10.3	3.9	0.6	1.4	1404
N+4	82.7	12.5	4.5	0.4	1.8	1292
N+5	81.0	13.1	5.9	0.1	1.9	1161
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	21.0	70.9	7.4	0.7	0.7	766
N+1	26.9	60.9	10.3	1.9	2.6	670
N+2	26.9	56.3	15.8	1.0	3.5	609
N+3	27.2	54.1	17.4	1.3	4.8	556
N+4	27.3	52.5	18.8	1.4	6.1	505
N+5	30.1	47.9	21.0	0.9	7.0	428
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	3.4	10.7	78.2	7.7	7.7	495
N+1	5.1	15.3	72.3	7.3	14.4	411
N+2	5.7	20.0	68.4	6.0	19.5	335
N+3	7.4	19.6	70.7	2.2	21.3	270
N+4	8.4	23.2	65.8	2.5	23.3	237
N+5	11.3	28.4	58.2	2.1	24.9	194

TABLE 302.

FOOD CLASS B * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	39.5	23.7	34.2	2.6	2.6	38
N+1	36.1	19.4	25.0	19.4	21.6	36
N+2	46.4	28.6	14.3	10.7	30.0	28
N+3	45.0	20.0	30.0	5.0	33.5	20
N+4	38.9	33.3	22.2	5.6	37.2	18
N+5	31.3	43.8	12.5	12.5	45.0	16
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	5.6	50.0	38.9	5.6	5.6	18
N+1	9.1	54.5	27.3	9.1	14.1	11
N+2	11.1	55.6	33.3	0.0	14.1	9
N+3	25.0	25.0	50.0	0.0	14.1	8
N+4	25.0	25.0	37.5	12.5	24.9	8
N+5	28.6	42.9	14.3	14.3	35.6	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	25.0	75.0	0.0	0.0	8
N+1	0.0	16.7	66.7	16.7	16.7	6
N+2	0.0	0.0	100.0	0.0	16.7	5
N+3	0.0	0.0	100.0	0.0	16.7	4
N+4	0.0	0.0	100.0	0.0	16.7	3
N+5	0.0	33.3	66.7	0.0	16.7	3

TABLE 303.

FCOD CLASS B * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	42.3	15.4	42.3	0.0	0.0	26
N+1	32.0	24.0	28.0	16.0	16.0	25
N+2	40.0	35.0	20.0	5.0	20.2	20
N+3	46.7	26.7	20.0	6.7	25.5	15
N+4	36.4	36.4	27.3	0.0	25.5	11
N+5	36.4	36.4	18.2	9.1	32.3	11
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	83.3	16.7	0.0	0.0	6
N+1	0.0	33.3	66.7	0.0	0.0	3
N+2	0.0	50.0	50.0	0.0	0.0	2
N+3	0.0	100.0	0.0	0.0	0.0	1
N+4	0.0	100.0	0.0	0.0	0.0	1
N+5	0.0	100.0	0.0	0.0	0.0	1
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	100.0	0.0	0.0	4
N+2	0.0	0.0	100.0	0.0	0.0	4
N+3	0.0	0.0	100.0	0.0	0.0	4
N+4	0.0	0.0	100.0	0.0	0.0	2
N+5	0.0	0.0	100.0	0.0	0.0	2

TABLE 304.

FCOD CLASS B * SUPPRESSED * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	97.4	2.0	0.4	0.2	0.2	544
N+1	92.3	7.1	0.4	0.2	0.4	535
N+2	89.2	9.0	1.8	0.0	0.4	498
N+3	87.6	10.0	2.2	0.2	0.6	491
N+4	85.1	12.0	2.7	0.2	0.8	483
N+5	83.6	12.6	3.8	0.0	0.8	445
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	13.5	79.2	7.2	0.0	0.0	207
N+1	23.1	65.3	11.1	0.5	0.5	199
N+2	23.2	58.4	17.8	0.5	1.0	185
N+3	23.0	56.9	20.1	0.0	1.0	174
N+4	20.2	55.4	23.8	0.6	1.6	168
N+5	24.8	50.3	24.8	0.0	1.6	145
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.8	13.2	74.6	10.5	10.5	114
N+1	5.7	18.4	72.4	3.4	13.6	87
N+2	5.4	23.0	66.2	5.4	18.3	74
N+3	8.5	30.5	57.6	3.4	21.1	59
N+4	11.1	29.6	57.4	1.9	22.5	54
N+5	14.0	27.9	58.1	0.0	22.5	43

TABLE 305.

FOOD CLASS C

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	86.7	11.4	1.9	0.0	0.0	308
N+1	85.6	10.4	2.2	1.8	1.8	278
N+2	74.9	16.3	7.0	1.9	3.6	215
N+3	59.7	18.8	20.8	0.7	4.3	144
N+4	58.1	21.3	19.9	0.7	5.0	136
N+5	58.9	18.6	21.7	0.8	5.7	129
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	28.4	56.7	13.4	1.5	1.5	67
N+1	47.1	31.4	15.7	5.9	7.3	51
N+2	35.3	38.2	20.6	5.9	12.7	34
N+3	18.8	37.5	31.3	12.5	23.6	16
N+4	36.4	36.4	27.3	0.0	23.6	11
N+5	30.0	10.0	60.0	0.0	23.6	10
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.5	10.5	78.9	0.0	0.0	19
N+1	14.3	0.0	28.6	57.1	57.1	14
N+2	0.0	0.0	40.0	60.0	82.9	5
N+3	0.0	0.0	100.0	0.0	82.9	2
N+4	0.0	0.0	50.0	50.0	91.4	2
N+5	0.0	0.0	100.0	0.0	91.4	1

TABLE 306.

FOOD CLASS C

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	96.1	3.3	0.6	0.0	0.0	180
N+1	93.7	4.0	1.1	1.1	1.1	174
N+2	78.7	13.5	6.5	1.3	2.4	155
N+3	71.0	19.0	9.0	1.0	3.4	100
N+4	70.5	21.1	7.4	1.1	4.4	95
N+5	72.5	15.4	11.0	1.1	5.5	91
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	51.5	36.4	9.1	3.0	3.0	33
N+1	66.7	14.8	11.1	7.4	10.2	27
N+2	50.0	31.8	18.2	0.0	10.2	22
N+3	20.0	40.0	30.0	10.0	19.2	10
N+4	28.6	42.9	28.6	0.0	19.2	7
N+5	28.6	0.0	71.4	0.0	19.2	7
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	18.2	9.1	72.7	0.0	0.0	11
N+1	10.0	10.0	30.0	50.0	50.0	10
N+2	0.0	0.0	50.0	50.0	75.0	4
N+3	0.0	0.0	100.0	0.0	75.0	2
N+4	0.0	0.0	50.0	50.0	87.5	2
N+5	0.0	0.0	100.0	0.0	87.5	1

TABLE 307.

FCOC CLASS C

DEFOLIATION HISTORY--HLH

YEAR	GOCC	FAIR	PCOR	DEAC	CUM. DEAC	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NC.
GCCD CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	62.0	30.0	6.0	2.0	2.0	5C
N+1	69.6	26.1	4.3	0.0	2.0	23
N+2	56.5	26.1	8.7	8.7	10.5	23
N+3	10.5	26.3	63.2	0.0	10.5	19
N+4	5.3	31.6	63.2	0.0	10.5	19
N+5	5.6	27.8	66.7	0.0	10.5	18
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	38.5	46.2	15.4	0.0	C.C	13
N+1	27.3	54.5	9.1	9.1	9.1	11
N+2	22.2	55.6	11.1	11.1	19.2	9
N+3	0.0	37.5	62.5	0.0	19.2	8
N+4	0.0	37.5	62.5	0.0	19.2	8
N+5	0.0	50.0	50.0	0.0	19.2	6
PCOR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	C.C	1
N+1	0.0	100.0	0.0	0.0	C.C	1
N+2	0.0	0.0	100.0	0.0	C.C	1
N+3	0.0	0.0	100.0	0.0	0.0	1
N+4	0.0	0.0	100.0	0.0	C.C	1
N+5	0.0	0.0	100.0	0.0	C.C	1

TABLE 308.

FOOD CLASS C

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	94.1	4.3	1.3	0.3	0.3	1491
N+1	92.0	5.5	1.5	1.0	1.3	1394
N+2	85.2	8.5	5.1	1.2	2.5	1347
N+3	84.1	9.8	5.6	0.6	3.1	1259
N+4	82.2	11.5	5.9	0.4	3.5	1152
N+5	77.1	14.8	7.8	0.3	3.7	1061
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	19.6	65.9	12.2	2.4	2.4	296
N+1	24.1	57.8	15.9	2.2	4.5	270
N+2	32.2	44.7	18.8	4.3	8.7	255
N+3	38.1	39.9	20.2	1.8	10.3	218
N+4	39.2	37.5	21.6	1.7	11.9	176
N+5	42.2	36.1	20.4	1.4	13.1	147
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.9	8.6	80.0	9.5	9.5	210
N+1	5.7	14.3	73.1	6.9	15.7	175
N+2	14.5	28.9	48.7	7.9	22.4	152
N+3	16.0	36.6	46.6	0.8	23.0	131
N+4	20.0	32.2	46.7	1.1	23.8	90
N+5	36.1	18.1	44.4	1.4	24.9	72

TABLE 309.

FCOD CLASS C * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	95.8	4.2	0.0	0.0	0.0	24
N+1	95.7	4.3	0.0	0.0	0.0	23
N+2	81.0	9.5	9.5	0.0	0.0	21
N+3	69.2	7.7	23.1	0.0	0.0	13
N+4	72.7	9.1	18.2	0.0	0.0	11
N+5	45.5	18.2	36.4	0.0	0.0	11
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	1
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	C
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.C	0.0	0.0	0.0	100.0	C
PCCR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	100.0	0.0	50.0	1
N+3	0.0	0.0	100.0	0.0	50.0	1
N+4	0.0	0.0	0.0	100.0	100.0	1
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 310.

FOOD CLASS C * DOMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	21
N+1	100.0	0.0	0.0	0.0	0.0	21
N+2	78.9	10.5	10.5	0.0	0.0	19
N+3	72.7	9.1	18.2	0.0	0.0	11
N+4	70.0	10.0	20.0	0.0	0.0	10
N+5	50.0	10.0	40.0	0.0	0.0	10
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	100.0	0.0	0.0	0.0	1
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	2
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	100.0	0.0	50.0	1
N+3	0.0	0.0	100.0	0.0	50.0	1
N+4	0.0	0.0	0.0	100.0	100.0	1
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 311.

FCOD CLASS C * COMINANT * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	96.9	2.3	0.8	0.0	0.0	26C
N+1	98.0	0.8	0.8	0.4	C.4	252
N+2	93.2	4.8	2.0	0.0	0.4	251
N+3	92.7	4.0	3.2	0.0	0.4	247
N+4	93.6	2.1	4.2	0.0	0.4	236
N+5	89.1	7.7	3.2	0.0	0.4	22C
FAIR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	12.5	62.5	25.0	0.0	0.0	16
N+1	21.4	42.9	35.7	0.0	0.0	14
N+2	50.0	33.3	16.7	0.0	0.0	12
N+3	54.5	36.4	9.1	0.0	0.0	11
N+4	66.7	22.2	11.1	0.0	0.0	9
N+5	77.8	22.2	0.0	0.0	0.0	9
POCR CCNDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	0.0	91.7	8.3	8.3	12
N+1	0.0	0.0	81.8	18.2	25.0	11
N+2	0.0	55.6	33.3	11.1	33.3	9
N+3	0.0	71.4	14.3	14.3	42.9	7
N+4	0.0	66.7	33.3	0.0	42.9	3
N+5	66.7	33.3	0.0	0.0	42.9	3

TABLE 312.

FCOD CLASS C * COMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	92.4	6.9	0.8	0.0	0.0	131
N+1	92.6	4.9	1.6	0.8	0.8	122
N+2	77.6	14.3	6.1	2.0	2.8	98
N+3	58.2	20.9	20.9	0.0	2.8	67
N+4	60.0	21.5	18.5	0.0	2.8	65
N+5	66.1	17.7	16.1	0.0	2.8	62
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	30.0	70.0	0.0	0.0	0.0	10
N+1	50.0	50.0	0.0	0.0	0.0	8
N+2	40.0	60.0	0.0	0.0	0.0	5
N+3	40.0	40.0	20.0	0.0	0.0	5
N+4	50.0	50.0	0.0	0.0	0.0	4
N+5	50.0	25.0	25.0	0.0	0.0	4
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 313.

FOOD CLASS C * DOMINANT * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	83
N+1	96.4	1.2	1.2	1.2	1.2	83
N+2	78.7	13.3	6.7	1.3	2.5	75
N+3	71.2	19.2	9.6	0.0	2.5	52
N+4	74.0	20.0	6.0	0.0	2.5	50
N+5	83.3	12.5	4.2	0.0	2.5	48
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	50.0	50.0	0.0	0.0	0.0	4
N+1	50.0	50.0	0.0	0.0	0.0	4
N+2	50.0	50.0	0.0	0.0	0.0	4
N+3	50.0	25.0	25.0	0.0	0.0	4
N+4	66.7	33.3	0.0	0.0	0.0	3
N+5	66.7	0.0	33.3	0.0	0.0	3
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	1
N+1	0.0	0.0	0.0	100.0	100.0	1
N+2	0.0	0.0	0.0	0.0	100.0	0
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 314.

FCCD CLASS C * DCMINANT * DIAMETER CLASS 2

DEFCLIATION HISTORY--HLH

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GCCD CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	71.4	28.6	0.0	0.0	0.0	21
N+1	83.3	8.3	8.3	0.0	0.0	12
N+2	75.0	16.7	0.0	8.3	8.3	12
N+3	0.0	40.0	60.0	0.0	8.3	1C
N+4	0.0	40.0	60.0	0.0	8.3	1C
N+5	0.0	40.0	60.0	0.0	8.3	1C
FAIR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	33.3	66.7	0.0	0.0	0.0	3
N+1	0.0	100.0	0.0	0.0	0.0	2
N+2	0.0	100.0	0.0	0.0	0.0	2
N+3	0.0	50.0	50.0	0.0	0.0	2
N+4	0.0	50.0	50.0	0.0	0.0	2
N+5	0.0	50.0	50.0	0.0	0.0	2
PCCR CCNDITICN BEFCRE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	C
N+1	0.0	0.0	0.0	0.0	0.0	C
N+2	0.0	0.0	0.0	0.0	0.0	C
N+3	0.0	0.0	0.0	0.0	0.0	C
N+4	0.0	0.0	0.0	0.0	0.0	C
N+5	0.0	0.0	0.0	0.0	0.0	C

TABLE 315.

FCOD CLASS C * COMINANT * DIAMETER CLASS 2

DEFCLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CCNDITICN AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	95.8	3.4	0.7	0.0	0.0	408
N+1	94.8	4.1	0.8	0.3	0.3	368
N+2	80.9	10.5	8.3	0.3	0.5	362
N+3	80.2	10.8	8.7	0.3	0.8	343
N+4	76.9	13.0	9.8	0.3	1.2	307
N+5	67.8	18.3	13.8	0.0	1.2	289
FAIR CCNDITICN AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	20.5	72.7	6.8	0.0	0.0	88
N+1	31.8	56.5	11.8	0.0	0.0	85
N+2	44.7	37.6	16.5	1.2	1.2	85
N+3	51.9	30.4	17.7	0.0	1.2	79
N+4	54.0	25.4	20.6	0.0	1.2	63
N+5	59.6	23.1	15.4	1.9	3.1	52
POCR CCNDITICN AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	2.9	7.2	88.4	1.4	1.4	69
N+1	6.2	18.5	70.8	4.6	6.0	65
N+2	27.1	39.0	32.2	1.7	7.6	59
N+3	25.9	43.1	31.0	0.0	7.6	58
N+4	25.7	45.7	25.7	2.9	10.2	35
N+5	46.4	35.7	17.9	0.0	10.2	28

TABLE 316.

FCOD CLASS C * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOCC	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	86.8	7.5	5.7	0.0	0.0	53
N+1	80.4	11.8	2.0	5.9	5.9	51
N+2	75.0	17.5	5.0	2.5	8.2	4C
N+3	62.5	25.0	8.3	4.2	12.1	24
N+4	50.0	36.4	9.1	4.5	16.1	22
N+5	45.0	25.0	25.0	5.0	20.3	2C
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	66.7	0.0	25.0	8.3	8.3	12
N+1	88.9	0.0	0.0	11.1	18.5	9
N+2	50.0	37.5	12.5	0.0	18.5	8
N+3	0.0	66.7	0.0	33.3	45.7	3
N+4	0.0	100.0	0.0	0.0	45.7	2
N+5	0.0	0.0	100.0	0.0	45.7	2
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	40.0	20.0	20.0	20.0	20.0	5
N+1	50.0	0.0	0.0	50.0	60.0	4
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.0	0.0	0.0	0.0	100.0	C

TABLE 317.

FCOD CLASS C * INTERMECIATE * DIAMETER CLASS 1

DEFCLIATION HISTORY--LLH

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	91.3	8.7	0.0	0.0	0.0	46
N+1	88.4	9.3	0.0	2.3	2.3	43
N+2	76.3	18.4	2.6	2.6	4.9	38
N+3	63.6	27.3	4.5	4.5	9.2	22
N+4	55.0	35.0	5.0	5.0	13.8	2C
N+5	47.4	26.3	21.1	5.3	18.3	19
FAIR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	88.9	0.0	11.1	0.0	0.0	9
N+1	100.0	0.0	0.0	0.0	0.0	8
N+2	50.0	37.5	12.5	0.0	0.0	8
N+3	0.0	66.7	0.0	33.3	33.3	3
N+4	0.0	100.0	0.0	0.0	33.3	2
N+5	0.0	0.0	100.0	0.0	33.3	2
PCOR CCNDITION BEFCRE FIRST HEAVY DEFOLIATION						
N	100.0	0.0	0.0	0.0	0.0	2
N+1	50.0	0.0	0.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	C
N+4	0.0	0.0	0.0	0.0	100.0	C
N+5	0.C	0.0	0.0	0.0	100.0	C

TABLE 318.

FOOD CLASS C * INTERMEDIATE * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	92.0	5.6	1.7	0.7	0.7	287
N+1	89.1	6.6	3.5	0.8	1.5	258
N+2	85.1	9.2	4.8	0.8	2.3	249
N+3	80.9	12.7	6.4	0.0	2.3	236
N+4	79.0	14.0	6.5	0.5	2.7	214
N+5	76.0	15.1	7.3	1.6	4.2	192
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	25.0	51.8	19.6	3.6	3.6	56
N+1	28.6	55.1	12.2	4.1	7.5	49
N+2	34.1	40.9	22.7	2.3	9.6	44
N+3	36.1	33.3	25.0	5.6	14.6	36
N+4	32.1	39.3	25.0	3.6	17.7	28
N+5	29.2	41.7	29.2	0.0	17.7	24
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	0.0	3.7	85.2	11.1	11.1	27
N+1	0.0	11.8	82.4	5.9	16.3	17
N+2	0.0	30.8	61.5	7.7	22.8	13
N+3	0.0	44.4	55.6	0.0	22.8	9
N+4	33.3	0.0	66.7	0.0	22.8	3
N+5	33.3	0.0	66.7	0.0	22.8	3

TABLE 319.

FOOD CLASS C * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	76.2	22.2	1.6	0.0	0.0	63
N+1	72.2	24.1	1.9	1.9	1.9	54
N+2	58.6	31.0	10.3	0.0	1.9	29
N+3	36.8	15.8	47.4	0.0	1.9	19
N+4	36.8	15.8	47.4	0.0	1.9	19
N+5	38.9	16.7	44.4	0.0	1.9	18
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	10.5	78.9	10.5	0.0	0.0	19
N+1	46.2	46.2	7.7	0.0	0.0	13
N+2	0.0	33.3	33.3	33.3	33.3	3
N+3	0.0	0.0	100.0	0.0	33.3	1
N+4	0.0	0.0	100.0	0.0	33.3	1
N+5	0.0	0.0	0.0	0.0	33.3	0
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	100.0	0.0	0.0	4
N+1	0.0	0.0	50.0	50.0	50.0	2
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 320.

FOOD CLASS C * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--HLH

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	54.2	37.5	8.3	0.0	0.0	24
N+1	55.6	44.4	0.0	0.0	0.0	9
N+2	33.3	44.4	22.2	0.0	0.0	9
N+3	12.5	12.5	75.0	0.0	0.0	8
N+4	12.5	12.5	75.0	0.0	0.0	8
N+5	12.5	12.5	75.0	0.0	0.0	8
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	44.4	44.4	11.1	0.0	0.0	9
N+1	33.3	44.4	11.1	11.1	11.1	9
N+2	28.6	42.9	14.3	14.3	23.8	7
N+3	0.0	33.3	66.7	0.0	23.8	6
N+4	0.0	33.3	66.7	0.0	23.8	6
N+5	0.0	50.0	50.0	0.0	23.8	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	0.0	0.0	0.0	0.0	0
N+1	0.0	0.0	0.0	0.0	0.0	0
N+2	0.0	0.0	0.0	0.0	0.0	0
N+3	0.0	0.0	0.0	0.0	0.0	0
N+4	0.0	0.0	0.0	0.0	0.0	0
N+5	0.0	0.0	0.0	0.0	0.0	0

TABLE 321.

FCOD CLASS C * INTERMEDIATE * DIAMETER CLASS 2

DEFOLIATION HISTORY--LLLLL

YEAR	GOCD	FAIR	PCOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOCD CONDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	93.6	4.3	1.6	0.5	0.5	187
N+1	91.5	6.2	1.1	1.1	1.7	177
N+2	85.0	7.2	6.6	1.2	2.8	167
N+3	83.9	9.4	5.4	1.3	4.1	149
N+4	81.9	11.6	5.1	1.4	5.5	138
N+5	75.4	15.1	9.5	0.0	5.5	126
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	20.5	64.1	10.3	5.1	5.1	39
N+1	16.7	63.9	16.7	2.8	7.8	36
N+2	18.8	56.3	12.5	12.5	19.3	32
N+3	28.0	56.0	16.0	0.0	19.3	25
N+4	30.0	55.0	15.0	0.0	19.3	20
N+5	28.6	50.0	14.3	7.1	25.1	14
POCR CONDITION AFTER FCURTH YEAR OF LIGHT DEFOLIATION						
N	2.9	5.7	82.9	8.6	8.6	35
N+1	10.7	7.1	78.6	3.6	11.8	28
N+2	12.0	12.0	68.0	8.0	18.9	25
N+3	15.8	36.8	47.4	0.0	18.9	19
N+4	18.8	31.3	50.0	0.0	18.9	16
N+5	36.4	0.0	63.6	0.0	18.9	11

TABLE 322.

FOOD CLASS C * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--H

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	78.4	18.9	2.7	0.0	0.0	37
N+1	82.1	10.7	7.1	0.0	0.0	28
N+2	77.8	11.1	7.4	3.7	3.7	27
N+3	76.2	14.3	9.5	0.0	3.7	21
N+4	73.7	15.8	10.5	0.0	3.7	19
N+5	77.8	16.7	5.6	0.0	3.7	18
FAIR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	26.1	56.5	17.4	0.0	0.0	23
N+1	31.6	26.3	36.8	5.3	5.3	19
N+2	35.3	35.3	23.5	5.9	10.8	17
N+3	14.3	28.6	42.9	14.3	23.6	7
N+4	50.0	0.0	50.0	0.0	23.6	4
N+5	25.0	0.0	75.0	0.0	23.6	4
POOR CONDITION BEFORE FIRST HEAVY DEFOLIATION						
N	0.0	14.3	85.7	0.0	0.0	7
N+1	0.0	0.0	25.0	75.0	75.0	4
N+2	0.0	0.0	0.0	100.0	100.0	1
N+3	0.0	0.0	0.0	0.0	100.0	0
N+4	0.0	0.0	0.0	0.0	100.0	0
N+5	0.0	0.0	0.0	0.0	100.0	0

TABLE 323.

FOOD CLASS C * SUPPRESSED * DIAMETER CLASS 1

DEFOLIATION HISTORY--LLLLL

YEAR	GOOD	FAIR	POOR	DEAD	CUM. DEAD	OBSNS.
	PCT.	PCT.	PCT.	PCT.	PCT.	NO.
GOOD CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	91.2	6.2	2.0	0.7	0.7	306
N+1	86.1	9.5	1.7	2.7	3.3	296
N+2	83.6	9.8	3.3	3.3	6.5	275
N+3	83.5	11.9	3.3	1.2	7.7	243
N+4	79.8	17.0	2.8	0.5	8.1	218
N+5	78.2	17.8	4.1	0.0	8.1	197
FAIR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	17.1	69.5	9.8	3.7	3.7	82
N+1	16.7	65.3	15.3	2.8	6.3	72
N+2	20.3	58.0	20.3	1.4	7.7	69
N+3	22.0	54.2	20.3	3.4	10.8	59
N+4	25.0	50.0	20.8	4.2	14.5	48
N+5	27.5	50.0	22.5	0.0	14.5	40
POOR CONDITION AFTER FOURTH YEAR OF LIGHT DEFOLIATION						
N	1.9	18.9	62.3	17.0	17.0	53
N+1	7.0	18.6	65.1	9.3	24.7	43
N+2	8.3	19.4	55.6	16.7	37.3	36
N+3	10.3	20.7	69.0	0.0	37.3	29
N+4	16.0	24.0	60.0	0.0	37.3	25
N+5	22.7	9.1	63.6	4.5	40.1	22

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by George W. Wendel

Results of a 20-Year Test of Hybrid Poplars in West Virginia

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Results of a 20-Year Test of Hybrid Poplars in West Virginia

AT THE END of 20 years, several hybrid poplar clones test-planted in West Virginia have attained an average diameter (d.b.h.) of more than 9 inches and heights of more than 70 feet.

In 1951, as part of a region-wide test of hybrid poplars, the Northeastern Forest Experiment Station established two outplantings in West Virginia—one on the Nursery Bottom near Parsons, and the other at Horseshoe Run near Leadmine. The 50 hybrids used (table 1) were developed by Stout and Schreiner (*1933*).

After 7 years, the Nursery Bottom plantation was destroyed to provide more nursery space. As of that time, the performance of the clones in both outplantings was reported on by Eschner (*1960*). Because of reduced manpower, subsequent measurements were continued on only the 13 clones at Horseshoe Run that were making the best growth in 1959.

This is a report on growth of these clones 11 years later.

THE STUDY

The study was begun in the spring of 1951 on a bottomland site along Horseshoe Run near Leadmine, West Virginia. Two complete blocks were planted, each with cuttings from 50 different hybrid poplar clones randomly distributed within each block. Each clone was represented in each block by a 16-tree plot. Dormant cuttings, 12 inches long, were planted at a spacing of 4 by 4 feet.

The planting is on a Pope gravelly silt loam, a well-drained alluvial soil. The area was plowed before planting, and the plantation was cultivated three times during the first growing season.

Total height measurements were recorded for all clones annually during the first 3 years of the study. From 1957 to 1965, d.b.h. and total-height measurements were taken at 2-year intervals on the 13 clones that were making the most rapid height growth as reported by Eschner (*1960*).

Table 1.—Clone numbers and parentage of material used in the Horseshoe Run hybrid poplar planting, 1951

Clone numbers	Parentage[1]
NE-2, -5, -279, -282	*P. nigra* L. x *P. laurifolia* Ledeb.
NE-9, -10	*P. nigra* x *P. trichocarpa* Torr. & Gray
NE-12, -301	*P. nigra* cv. Betulifolia x *P. trichocarpa*
NE-14	*P. nigra* cv. Charkowienses x *P. deltoides* Bartr.
NE-18, -21	*P. nigra* cv. Charkowienses x *P. nigra* cv. Caudina
NE-29, -322	*P. nigra* cv. Charkowienses x *P. trichocarpa*
NE-31	*P. nigra* cv. Charkowienses x Unidentified Cottonwood
NE-305	*P. nigra* cv. Charkowienses x *P. nigra* cv. Plantierensis
NE-33	*P. deltoides* cv. Angulata x *P.* x *berolinensis* Dipp.
NE-34, -259	*P. deltoides* cv. Angulata x *P. nigra* cv. Incrassata
NE-251, -256, -258	*P. deltoides* cv. Angulata x *P. trichocarpa*
NE-261	*P. deltoides* cv. Angulata x *P. nigra* cv. Plantierensis
NE-264	*P. deltoides* cv. Angulata x *P. Nigra* cv. Volga
NE-41, -42	*P. maximowiczii* Henry x *P. trichocarpa*
NE-43, -44, -46, -47, -48, -49, -50	*P. maximowiczii* x *P.* x *berolinensis*
NE-51, -52	*P. maximowiczii* x *P. nigra* cv. Plantierensis
NE-53	*P. maximowiczii* x *P. nigra* cv. Caudina
NE-200, -205, -206, -209, -212, -213, -219	*P. deltoides* x *P. trichocarpa*
NE-223, -224, -227	*P. deltoides* x *P. nigra* cv. Caudina
NE-229	*P. deltoides* x *P.* x *berolinensis*
NE-235	*P. deltoides* x *P.* x *canadensis* Moench cv. Incrassata
NE-239	*P. deltoides* x *P. nigra* cv. Volga
NE-241	*P. deltoides* x *P. nigra* cv. Plantierensis
NE-333	*P. simonii* Carr. x *P.* x *berolinensis*

[1] Full names are in accordance with the International Code of Nomenclature for Cultivated Plants.

The 13 clones were remeasured for the last time at the end of the 1970 growing season.

Two thinnings—one in 1960 and one in 1965—have reduced the number of trees in each plot from 16 to 4. In 1960, the 8 largest and most vigorous trees were retained; and in 1965, the best 4 of these were retained.

In the winter of 1970-71, 29 trees ranging in size from 5 to 12 inches d.b.h. were cut and measured, and a local volume table was prepared. Each 1-inch diameter class was represented by at least three trees.

GROWTH

An analysis of variance showed that clones differed significantly (1-percent probability level) in d.b.h. and total height at the end of 20 years (table 2). The Student-Newman-Keuls multiple-range test (*Steel and Torrie 1960*) was used to determine which clones were significantly different. In this test, means underscored by the same line do not differ significantly at the 5-percent probability level.

Diameter growth.—The Student-Newman-Keuls test showed that clones NE-50, -43, -41, -46, -42, and -51—which averaged between 9.4 and 10.0 inches d.b.h. at 20 years—differed significantly from clones NE-256, -53, -29, -49, and -206—which averaged between 5.7 and 6.9 inches d.b.h. (table 3). Two clones, NE-52 and -47—8.0 and 7.5 inches d.b.h. respectively—did not differ significantly, but did overlap and were judged not significantly different from some of the clones in the slower growing group.

Clone NE-50 had the greatest average d.b.h. —10.0 inches—but the largest single tree—13.0 inches—occurred in clone NE-41. The smallest trees occurred in clones NE-49 and NE-206; trees in each of these two clones averaged about 5.7 inches.

Average annual d.b.h. growth ranged from 0.29 inch for clones NE-49 and NE-206 to 0.50 inch for clone NE-50 (table 3).

Total height growth.—When tested for sig-

Table 2.—Analysis of variance tables for total height and d.b.h. at the end of 20 years

Source of variation	D.F.	Sums of squares	Mean square	F
		AVERAGE D.B.H.		
Blocks	1	0.34	0.34	1.50
Clones	12	72.89	6.07	26.74**
Error	12	2.73	.23	—
Total	25	75.96	—	—
		AVERAGE TOTAL HEIGHT		
Blocks	1	2.10	2.10	.110
Clones	12	1,976.73	164.73	8.68**
Error	12	227.63	18.97	—
Total	25	2,206.46	—	—

Table 3.—Twenty-year d.b.h. and total-height data on 13 hybrid poplar clones at Horseshoe Run

Block	Clone NE-												
	206	49	29	53	256	47	52	51	42	46	41	43	50
	D.B.H. (*Inches*)												
I	6.1	5.8	5.9	7.1	7.2	7.3	8.1	9.4	8.9	9.3	9.9	10.4	10.2
II	5.2	5.6	6.0	5.7	6.6	7.6	7.8	9.3	10.1	9.7	9.8	9.4	9.8
Average	5.65	5.70	5.95	6.40	6.90	7.45	7.95	9.35	9.50	9.50	9.85	9.90	10.00
Average annual d.b.h. growth	0.29	0.29	0.30	0.32	0.35	0.38	0.40	0.47	0.48	0.48	0.49	0.50	0.50
$S_x = 0.3391$													

Block	Clone NE-												
	49	256	206	29	47	52	53	42	43	41	51	46	50
	TOTAL HEIGHT (*Feet*)												
I	54.2	52.5	60.5	54.0	60.1	56.2	62.3	62.2	74.3	69.7	71.5	74.0	81.5
II	54.5	57.2	50.7	60.0	54.5	62.5	58.5	71.3	65.5	70.7	75.0	80.5	79.5
Average	54.4	54.9	55.6	57.0	57.3	59.4	60.4	66.8	69.9	70.2	73.3	77.3	80.5
Average annual height growth	2.7	2.7	2.8	2.9	2.9	3.0	3.0	3.3	3.5	3.5	3.7	3.9	4.0
$S_x = 3.08$													

nificant differences in total heights, the clones fell in two groups: the faster growing group—NE-50, -46, -51; and the slower growing clones NE-53, -52, -47, -29, -206, -256, and -49. Three clones—NE-41, -43, and -42—overlapped and were not significantly different from either group (table 3). Within the groups, total height did not differ significantly at the 5-percent level of probability.

Total heights ranged from 54.4 to 60.4 feet in the shorter group and from 73.3 to 80.5 feet in the taller group. The tallest tree—87.0 feet—was in clone NE-50, which averaged 80.5 feet (fig. 1). The shortest tree was in clone NE-49, which averaged 54.4 feet. Two intermediate groups of clones did not differ significantly in total height and overlapped both the faster and slower growing groups (table 3).

Average annual height growth ranged from 2.7 feet for clones NE-49 and NE-29 to 4.0 feet for clone NE-50 (table 3).

Volume table.—Volume in cubic feet was computed (*Hampf and Bickford 1959*) for 29 trees ranging in size from 5.0 to 12.0 inches d.b.h. By regression methods, equations were calculated for estimating cubic-foot volume to a top diameter of 4 inches inside bark (equations 1 and 2).

$$\text{Cubic-foot volume (including bark)} \quad 1.237417 + 0.002726\ (D^2H) \qquad [1]$$

Figure 1.—Clone NE-50 at the end of 20 growing seasons.

$$\text{Cubic-foot volume (without bark)} = 1.042011 + 0.002531\ (D^2H) \qquad [2]$$

In equation 1, volume included the bark; in equation 2, bark volume was not included. Then, with the equations, the volumes for various combinations of d.b.h. and merchantable stem length were determined (tables 4 and 5). The underlined portions of the tables indicate the range of the data.

For both equations, the coefficient of determination was 0.993; the standard error of estimate for equation 1 was 0.59 cubic feet and for equation 2 was 0.55 cubic feet.

DISCUSSION

The study showed that clones NE-50, -41, -43, -46, -42, and -51 grew better than the other clones during the 20 years of the test. With the exception of clone NE-42, these were also the fastest growing (in height) in 1959 (*Eschner 1960*). These same clones also had the largest annual diameter growth for the 20-year period.

Since the test was made on one site, we can expect similar growth only if these clones are planted on areas having the same soils and subject to the same climatic conditions. For example, these same clones, planted on an upland site, might not grow as well as others that ranked lower in this test.

Table 4.—Cubic-foot volumes, outside bark, for hybrid poplars[1]

D.b.h.	Merchantable height (feet)											
	10	15	20	25	30	35	40	45	50	55	60	65
5	1.9	2.3	2.6	—	—	—	—	—	—	—	—	—
6	—	—	3.2	3.7	4.2	4.7	—	—	—	—	—	—
7	—	—	3.9	4.6	5.2	5.9	6.6	—	—	—	—	—
8	—	—	—	—	6.5	7.3	8.2	9.1	10.0	—	—	—
9	—	—	—	—	—	9.0	10.1	11.2	12.3	13.4	—	—
10	—	—	—	—	—	—	—	13.5	14.9	16.2	17.6	18.9
11	—	—	—	—	—	—	—	16.1	17.7	19.4	21.0	22.7
12	—	—	—	—	—	—	—	18.9	20.9	22.8	24.8	26.8

[1] Merchantable length, to a top diameter of 4 inches, inside bark.

Table 5.—Cubic-foot volumes, inside bark, for hybrid poplars[1]

D.b.h.	Merchantable height (feet)											
	10	15	20	25	30	35	40	45	50	55	60	65
5	1.7	2.0	2.3	—	—	—	—	—	—	—	—	—
6	—	—	2.9	3.3	3.8	4.2	—	—	—	—	—	—
7	—	—	3.5	4.1	4.8	5.4	6.0	—	—	—	—	—
8	—	—	—	—	5.9	6.7	7.5	8.3	9.1	—	—	—
9	—	—	—	—	—	8.2	9.2	10.3	11.3	12.3	—	—
10	—	—	—	—	—	—	—	12.4	13.7	15.0	16.2	17.5
11	—	—	—	—	—	—	—	14.8	16.4	17.9	19.4	20.9
12	—	—	—	—	—	—	—	17.4	19.3	21.1	22.9	24.7

[1] Merchantable length to a top diameter of 4 inches inside bark.

A possible limitation to rotations longer than 20 years is the occurrence of stem cankers caused by *Fusarium solina.* (Personal communication from F. R. Berry, USDA Forest Service, Forest Insect and Disease Laboratory, Delaware, Ohio, 12 August 1971.) The cankers are fairly common on the upper stem, often girdling the stems and causing the tops to die. Schreiner (*1959*) recommends that random mixtures of clones of different parentage be used in plantations to provide assurance against extensive disease losses.

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STAND CHANGES
In the First 10 Years After Seedbed Preparation
FOR PAPER BIRCH

by John C. Bjorkbom

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CHANGES MAY take place rapidly in young forest stands. Stands that appear good may deteriorate unexpectedly: stands that hold little promise initially may suddenly show great potential. The ability to understand and predict such changes increases our ability to prescribe effective silvicultural treatments.

In 1958, the Northeastern Forest Experiment Station began a study of the influence of seedbed-preparation methods on paper birch (*Betula papyrifera* Marsh.) regeneration in Maine. The initial results indicated that, the greater the soil disturbance, the greater the amount of paper birch regeneration. However, this effect was short-lived. Ten years after the study was begun, there was a substantial reduction in the total number of stems per acre, accompanied by significant changes in species composition and dominance. Mortality and slow growth rate of the paper birch seedlings diminished the relative importance of this species in the developing stand.

THE STUDY AREA

The study was made in a 70-year-old second-growth stand in the Penobscot Experimental Forest near Orono, Maine. The stand contained 8 cords per acre of all species. Paper birch accounted for 75 percent of the volume and for 26 percent of the number of trees. Other species representing significant proportions of the total number of stems included red maple (*Acer rubrum* L.), which made up 35 percent; American beech (*Fagus grandifolia* Ehrh.), which made up 22 percent; and softwood species, which made up 11 percent.

The softwoods were principally balsam fir (*Abies balsamea* (L.) Mill.), white spruce (*Picea glauca* (Moench) Voss), red spruce (*Picea rubens* Sarg.), and eastern white pine (*Pinus strobus* L.). Minor numbers of other hardwoods were also present, including gray birch (*Betula populifolia* Marsh.), pin cherry (*Prunus pensylvanica* L. f.), northern red oak (*Quercus rubra* L.), and eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch).

The terrain on the study area slopes slightly to the northeast. The soil is the Thorndike stony silt loam, well-drained and shallow to a fractured shale bedrock.

STUDY METHODS

Four seedbed-preparation methods were tested: (1) disking after winter logging, (2) burning after winter logging, (3) summer logging only, and (4) winter logging only. Each treatment was applied to two 0.45-acre plots.

Before any logging was done, paper birch seed trees were selected. Reserved from cutting, they were evenly distributed at a density of 14 trees per acre.

Winter logging was done in March 1958 when snow was still on the ground. Summer logging was done in June 1958. The merchantable wood was stump-cut and tractor-yarded with a rubber-tired flat trailer. The unmerchantable trees, the saplings, and the advance growth over 3 feet tall were cut and left. In effect, the only trees remaining after logging were the seed trees and the advance growth less than 3 feet tall.

The disking was done in August 1958. To facilitate this operation, the stumps were cut to ground level; and all the slash was removed from the plots. Even so, repeated passes with a harrow were required for complete scarification of the soil.

The burning treatment also was carried out in August 1958. To confine the fire within prescribed limits, the slash was pulled back from the plot boundaries. Most of the smaller slash was consumed in the burning.

In April 1959, the hardwood sprouts—except for paper birch and gray birch—were cut back; and the stubs were treated with 2, 4, 5-T.

Each plot contained 100 randomly located milacre subplots on which species composition and dominance were determined. Estimates of the number of stems per acre were based on ¼-milacre samples of 20 randomly selected milacre subplots. These measurements and observations were made on all plots at the end of each growing season from 1958 to 1963.

In 1968, each treatment plot was divided into 18 subplots, each 0.5 by 0.5 chains. At the end of the growing season, a 100-percent tally of all stems of seedling origin taller than 4.5 feet on each subplot was made by species and by 1-inch diameter classes. This choice of height was arbitrary but seemed to be the lower limit of the main crown canopy in all plots and included all species. Estimates of the number of stems less than 4.5 feet tall were based on tallies of the same ¼ milacres used in the 1958-63 inventories. These smaller stems were tallied by species only.

The height and diameter of the tallest tree of seedling origin on each subplot were measured and were recorded by species. Height was measured to the nearest ½ foot; diameter was tallied by 1-inch classes. If the tallest tree was not a paper birch, then the tallest paper birch was also measured.

All stump sprouts were tallied by species, and the number of stems per clump was recorded. The diameter at breast height and the height of the tallest sprout were measured in each clump.

EARLY RESULTS

The 1958 paper birch seedfall was an estimated 1.3 million seeds per acre, with an average germination of 13 percent (*1*). This seed, fairly evenly distributed over the study area, regenerated most of the new stand. Succeeding seed crops contributed relatively little to the total regeneration except through seeding the open areas left from the previous year.

Much of the paper birch seed falling on the disked plots and on the burned plots found a favorable seedbed—70 percent or more of these areas were in exposed mineral soil (*1*). On the other hand, only about 5 percent of the summer-logged and winter-logged areas was exposed mineral soil.

Temperature and moisture conditions during the first growing season (May through September 1959) seemed favorable for seed germination and seedling survival. Records from the U. S. Weather Bureau station at Old Town, Maine—9 miles northwest of the study area—indicated that both temperature and rainfall in this period were above their long-term means (*15, 16*). No extended periods of excessively high temperatures were recorded, and rain fell at rather regular and frequent intervals. (*10, 11, 12, 13, 14*).

At the end of the first growing season (1959), the number of paper birch seedlings per acre by treatment and the ratio of seeds to seedlings by treatment were as follows:

Treatment	*Seedlings per acre*	*Ratio, seeds to seedlings*
Disking	245,400	6 : 1
Burning	50,100	14 : 1
Summer logging	65,700	28 : 1
Winter logging	33,700	36 : 1

STAND CHANGES

During the 10-year period of observation, a number of changes occurred that have drastically altered the stands. The total number of stems per acre peaked in 1959, dropped sharply the following year, and then continued in a downward trend at a diminishing rate. The species composition changed; and paper birch lost its early supremacy, thus giving the other species a relatively greater prominance.

Number of Stems

Regardless of treatment, most of the decrease in number of stems per acre was in the hardwood seedlings (table 1). The softwood seedlings, most common after the logging-only treatments, were fairly stable in number. Hardwood sprouts, also most common after logging only, decreased after 1959 as a result of a sprout-control program to eliminate all but paper birch and gray birch sprouts. However, this program was only partly successful, and sprouts of other hardwood species were also present.

The greatest decrease in numbers of stems occurred on the disked plots. However, considering the great number of stems (primarily hardwood germinants) that regenerated on these plots, high mortality was to be expected in this treatment. Then, too, the disking itself probably contributed to the mortality. Most seedlings survive best in partial shade and with

Table 1.—Total number of stems per acre by treatment, origin, species group, and year of observation

[In thousands of stems]

Origin and species group	Year of observation						
	1958	1959	1960	1961	1962	1963	1968
DISKING							
Seedlings:							
Hardwood	1	282	138	101	75	65	11
Softwood	(1)	1	(1)	1	1	1	(1)
Sprouts	11	2	2	(1)	(1)	(1)	1
Total	12	285	140	102	76	66	12
BURNING							
Seedlings:							
Hardwood	2	62	30	26	(2)	25	9
Softwood	0	(1)	0	(1)	(2)	0	1
Sprouts	7	2	(1)	(1)	(2)	(1)	1
Total	9	64	30	26	(2)	25	11
SUMMER LOGGING							
Seedlings:							
Hardwood	2	77	26	24	21	21	4
Softwood	5	5	3	4	5	4	3
Sprouts	8	7	4	3	3	2	2
Total	15	89	33	31	29	27	9
WINTER LOGGING							
Seedlings:							
Hardwood	10	43	18	19	11	10	4
Softwood	3	2	2	2	2	2	2
Sprouts	22	6	8	6	8	4	2
Total	35	51	28	27	21	16	8

Note: Increases shown in the table after 1959 are due to rounding off estimates and to sampling procedures.

[1] Fewer than 500 stems per acre.

[2] Remeasurement errors gave unreliable estimates.

adequate moisture. This is particularly true of paper birch (*6*).

However, the seedbed after disking had little micro-relief and no logging slash or woody vegetation to provide shade sufficient to reduce surface soil temperatures and to help conserve moisture. In addition, some grasses were able to establish themselves in this rather harsh environment and subsequently choked out some of the new seedlings (fig. 1).

Both disking and burning after logging appear to have stimulated the ingrowth of sweetfern (*Comptonia peregrina* (L.) Coult.). Occurring characteristically in large openings and on dry sites, this shrub forms dense patches in which the competition appears so severe that only a few tree seedlings have been able to struggle up through the canopy (fig. 2).

The magnitude of the changes in number of stems per acre on the burned, summer-logged, and winter-logged plots were remarkably similar. Accumulations of slash, advance growth, or unburned materials on these plots served to moderate the environment and probably contributed to the relative equality in numbers.

Seedling Species

Based on the number of stems of seedling origin per acre, paper birch was the predominant species in all plots in most years. But there were obvious differences by treatment in the other species.

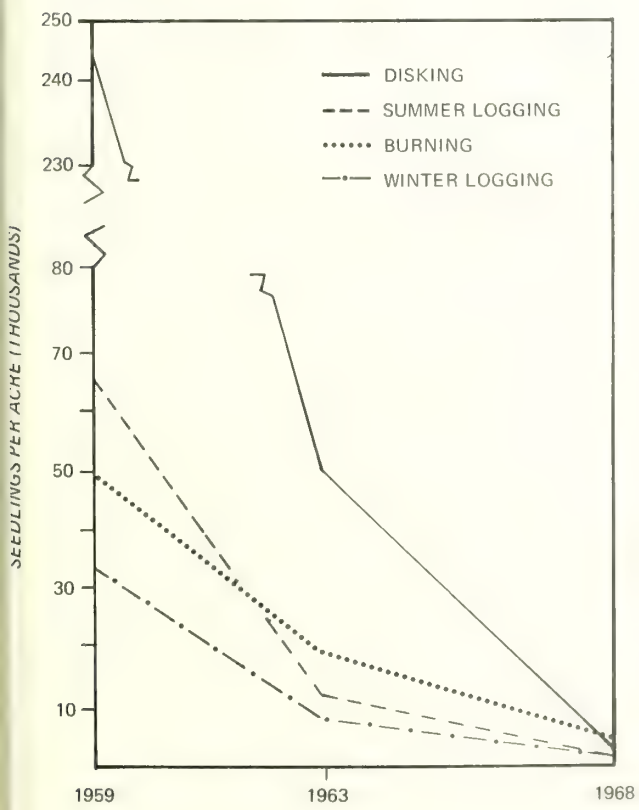
Seedbed preparation after logging led to a preponderance of the pioneer species. In the disked plots, aspen ranked second in number to paper birch for the first 5 years. But by the end of the second 5-year period, aspen predominated. On the burned plots, gray birch was initially second to paper birch, but was replaced eventually by aspen. Softwood species were least common on all these plots; trees of these species were advance growth, and most were destroyed by the disking and burning.

Figure 1.—Some portions of the disked areas are still not satisfactorily regenerated after 10 growing seasons. Here only a few scattered aspens and advance growth of softwoods are visible.

Figure 2.—Competition from sweetfern is sometimes so severe that tree species are slow to regenerate. Here, after 10 growing seasons, only an occasional aspen has been able to break through a cover of sweetfern 3 feet high.

Figure 3.—Softwoods present in the stand before treatment and not destroyed by treatment are a major component of the new stand.

Figure 4.—In all treatments, the number of paper birch seedlings decreased rapidly over the 10-year period.



In plots that were logged only, paper birch ranked first in abundance; and softwood species ranked second for almost the entire 10-year period. The softwoods were present at the start of the study as advance growth (fig. 3).

Although the relative ranking of paper birch did not vary, there were substantial decreases in the number of stems of this species (fig. 4), the greatest decreases occurring on the disked areas. After 10 growing seasons, there were about 4,800 paper birch seedlings per acre on the burned plots, 3,300 on the disked plots, 1,900 on the winter-logged plots, and 1,700 on the summer-logged plots. Changes in the other species were relatively small on all plots.

The proportion of paper birch seedlings also declined. But despite the decreases, 10 years after the start of the study, paper birch still accounted for at least 25 percent of the stems and up to as much as 48 percent (table 2), depending on the treatment.

Tree Height

Height of the paper birch trees of seedling origin is important in evaluating the results of this study. If the paper birch trees are in the main crown canopy (at least 4.5 feet tall), then they have a better opportunity to survive and grow well. Otherwise, they will gradually

Table 2.—Seedling distribution as a percent of the total number of seedlings after 10 growing seasons, by treatment and species, September 1968

Species	Treatment			
	Disking	Burning	Summer logging	Winter logging
	Pct.	*Pct.*	*Pct.*	*Pct.*
Paper birch	29	48	25	35
Aspen	38	26	7	7
Gray birch	12	13	17	3
Pin cherry	3	2	2	(1)
Other hardwoods	14	5	11	24
Softwoods	4	6	38	31
Total	100	100	100	100
Total number of seedlings per acre	11,300	10,100	6,900	5,500

[1] Less than 0.5 percent.

fall behind and eventually will drop out of the stand.

Although abundant paper birch regeneration was obtained on all plots, 12 percent or fewer seedlings had reached 4.5 feet in height by the end of the tenth growing season (table 3). In general, the proportion of taller trees on the disked areas was only one-third to one-fourth that on the other areas; in actual numbers per acre, the burned areas exceeded all others.

Within the main crown canopy, paper birch occupied a subordinate position. Faster growing species and advance reproduction were nearly twice as tall as the paper birch (table 4). Treatment made a difference in which species were dominant. Where disking or burning was used, 87 percent of the dominant trees were aspen, 10 percent were softwoods, and 3 percent were other hardwoods. On areas that were logged only, 58 percent of the taller trees were softwoods, 36 percent were aspen, and 6 percent were other hardwoods.

Table 3.—Number and percent of paper birch seedlings per acre after 10 growing seasons, by height class and treatment, September 1968

Treatment	Height class				
	4.5 feet and taller		Less than 4.5 feet		Total
	No.	*Pct.*	*No.*	*Pct.*	*No.*
Disking	100	3	3200	97	3300
Burning	500	10	4300	90	4800
Summer logging	200	11	1500	89	1700
Winter logging	200	12	1700	88	1900

Table 4.—Average height of the tallest trees[1] of seedling origin, after 10 growing seasons by species or species group and treatment, September 1968

Species	Treatment			
	Disking	Burning	Summer logging	Winter logging
	Feet	*Feet*	*Feet*	*Feet*
Paper birch	5.0	7.1	6.4	6.7
Aspen	13.2	15.0	22.6	18.2
Other hardwoods	9.0	10.5	16.0	16.7
Softwoods	9.7	13.0	14.0	14.3

[1] Based on the tallest tree on each subplot.

Tree Diameter

Most of the trees taller than 4.5 feet were less than 0.5 inch d.b.h. However, there were treatment and species differences (table 5).

In a large measure, these differences were a reflection of the presence or absence of advance growth. The logging-only treatments have a higher proportion of large-diameter trees simply because these trees were left after the treatments were applied. Aspen is an exception. Although this species regenerated only after treatment, its rapid growth has resulted in a substantial proportion of the aspen component

Table 5.—Distribution of trees[1] of seedling origin by diameter class and treatment after 10 growing seasons, September 1968

Species	Diameter class	Treatment			
		Disking	Burning	Summer logging	Winter logging
		Pct.	*Pct.*	*Pct.*	*Pct.*
Paper birch	under 1-inch	98	96	96	98
	1-inch	2	4	4	2
	over 1-inch	0	0	0	0
Aspen	under 1-inch	74	65	70	68
	1-inch	26	34	22	28
	over 1-inch	0	1	8	4
Pin cherry	under 1-inch	90	92	89	95
	1-inch	10	8	11	5
	over 1-inch	0	0	0	0
Gray birch	under 1-inch	95	100	100	93
	1-inch	5	0	0	7
	over 1-inch	0	0	0	0
Other hardwoods	under 1-inch	85	78	65	61
	1-inch	15	22	34	38
	over 1-inch	0	0	1	1
Softwoods	under 1-inch	59	57	47	41
	1-inch	39	39	45	52
	over 1-inch	2	4	8	7

[1] Includes only trees that were at least 4.5 feet tall.

in the 1-inch diameter class. In general, the regeneration of other species—principally paper birch—was slower growing; so it remained in the lowest diameter class.

Hardwood Sprouts

Sprouts were very common on all plots at the end of the 1958 growing season. Because they might obscure the effects of seedbed preparation on paper birch regeneration, the hardwood sprouts—except paper and gray birch—were cut; and the cut surfaces were treated with 2,4,5-T in the spring of 1959. Although this treatment was not entirely successful in killing off all the sprouts, the number was greatly reduced.

Sprouts were still present in 1968. They were most common on the summer-logged and the winter-logged plots, where they represented 25 percent (2,000 per acre) of the total number of stems (fig. 5). Even though disking and burning killed some stumps outright and reduced the sprouting capacity of others, weak sprouting occurred. About 5 percent (500 per acre) of the total number of stems on these plots were of sprout origin.

Red maple sprouts outnumbered all other sprouts combined, and paper birch sprouts were the tallest; gray birch had more sprouts per stump than did any other species (table 6).

POTENTIAL CROP TREES

To be a potential crop tree, a paper birch tree should be well up in the crown canopy and should have a good chance of reaching merchantable size. But after 10 growing seasons, relatively few of the paper birches exceeded the arbitrary lower limit (4.5 feet) of the main crown canopy; so most cannot qualify as potential crop trees. The paper birch reproduction in the burning-treatment plots shows the most promise. There are twice as many potential crop trees of seedling origin in these plots as there are on the logged-only plots and nearly 5 times as many as there are on the disked plots.

Table 6.—Growth characteristics of sprouts after 10 growing seasons, by species, September 1968

Species	Sprouts—		Diameter distribution[1]		Average height tallest sprout per stump
	Per acre	Per stump	1.5 inches and smaller	more than 1.5 inches	
	No.	*No.*	*Pct.*	*Pct.*	*Feet*
Red maple	2881	6.3	97	3	11.3
Paper birch	1482	5.7	69	31	12.7
Beech	565	4.1	100	—	9.3
Gray birch	94	9.4	73	27	12.2
Other hardwood	14	2.6	80	20	11.9

[1] Based on diameter of the tallest sprout in each clump.

Figure 5.—Logging-only treatments have resulted in many paper birch sprouts; but many of these are of poor form, and all are relatively small. The largest sprout seen here is only 1 inch d.b.h. and 14 feet high after 10 growing seasons.

Paper birch sprouts at least 4.5 feet tall should also be included in an estimate of the number of potential crop trees. A conservative estimate of this number would be one sprout per sprouting stump. On this basis, the logged-only plots have the greatest number of potential crop trees of sprout origin—100 to 120 per acre. The burned plots had less than one-third of this number, and the disked plots had less than one-fifth.

In total, after 10 growing seasons, the greatest number of potential crop trees per acre was found on the burned plots—about 500 per acre (table 7). The logged-only plots had about 300 per acre, and the disked plots had about 100 per acre.

Table 7.—Number of paper birch potential crop trees after 10 growing seasons, by treatment and origin, September 1968

Treatment	Origin		Total
	Seedling	Sprout	
	No.	*No.*	*No.*
Disking	94	13	107
Burning	482	27	509
Summer logging	190	99	289
Winter logging	222	121	343

DISCUSSION

Different seedbed-preparation methods make a difference in the amount of paper birch regeneration developing soon after treatment. But under the conditions of this study, the initial effects were short-lived.

Disking stimulated far more paper birch regeneration than did any other treatment. After one growing season, the number of seedlings after disking was roughly five times the average number in the other three methods combined. Mortality was also higher. At the end of the tenth growing season, there were fewer paper birch seedlings after disking than after burning and not quite twice as many seedlings as after the summer- and winter-logging treatments.

Burning did not regenerate as much paper birch as did disking or summer logging, but seedling survival was better than in any other treatment. After 10 growing seasons, there were 1.5 times as many paper birch seedlings on the burned areas as on the disked areas and 2.7 times as many as on the summer-logged and winter-logged areas.

Improved birch regeneration after scarification or burning to break up the humus cover or expose mineral soil has also been reported for paper birch in New Hampshire (*4*) and for *Betula verrucosa* Ehrh. and *Betula pubescens* Ehrh. in Finland (*8*).

Summer logging and winter logging resulted in less paper birch regeneration. After five growing seasons, these treatments had only one-half as many seedlings as the burning treatment and only one-fifth as many as the disking treatment. Yet these relative amounts were rather substantial: 12,000 seedlings per acre after summer logging and 8,000 per acre after winter logging (*1*). These amounts were somewhat larger than might have been expected, based on the results of a clearcutting in New Hampshire (*5*). Presumably, seed trees made the difference: they were retained in the study reported here but not in New Hampshire. Nevertheless, at the end of 10 growing seasons, there were fewer than 2,000 paper birch seedlings per acre on these logged-only areas.

Despite the number of paper birch seedlings, their growth was disappointing. After 10 years, 88 percent or more of the total number of these seedlings were less than 4.5 feet tall. The tallest birch seedlings over 4.5 feet in height averaged only 5 to 7 feet, depending on treatment. Most of these trees were less than 0.5 inch in diameter. Paper birch sprouts ranged up to 13 feet in height, and most were less than 1.5 inches in diameter. Observations of height and diameter growth elsewhere in Maine and in New Hampshire show that, at age 10, seedlings might be expected to be about 10 feet high and 1 inch in diameter, and sprouts might be expected to be about 19 feet high and 2 inches in diameter (*3*).

The reasons for this poor growth are not entirely clear. Although paper birch occurs on a wide range of soil and moisture conditions, the soil in the study area was not the fresh, well-drained sandy loam on which this species reaches its best development (*9*). This alone very likely accentuated the effects of those factors detrimental to the growth of paper birch. Then, too, browsing probably had a significantly adverse effect on tree height because paper birch appeared to be a favored browse species.

Seedbed-preparation methods have also influenced the other forest tree species. Aspen, gray birch, and pin cherry—pioneer species of little or no commercial value now—were much more abundant after disking and burning than after logging only. On the other hand, a relatively high proportion of commercially valuable hardwoods and softwoods was present after both summer and winter logging.

Both disking and burning tend to favor the regeneration of pure stands of paper birch. If this is the management objective, then the regeneration areas should be so prepared. But because these treatments add to the management costs, their use should probably be limited to the best sites or to those sites that, for some compelling reason, must be regenerated with paper birch.

If the maximum amount of paper birch regeneration is to be produced without extra effort to expose mineral soil, then the regeneration area must be effectively seeded, and the undisturbed seedbeds must not become excessively hot and dry. Effective seeding between seed crops can be achieved by leaving seed trees on the regeneration area or by keeping the regeneration area within the zone of adequate seed dispersal (*2*) from the residual stand. Or it can be achieved by logging in the winter after the bulk of the seed crop has been dispersed. The temperature of the seedbed can be moderated, and the soil moisture can be maintained at higher levels by using cuttings that provide at least partial shade (*7*).

Regardless of what methods are used to get paper birch regeneration on the ground, these

seedlings must be retained in the developing stand. The key to this is likely to be silvicultural treatments beginning early in the life of the stand. Although paper birch generally asserts dominance over most other tree species, it is sometimes overtopped by advance growth, by less valuable species, and by sprouts. Carefully selected paper birch potential crop trees should be released from such competitors and then maintained in a free-to-grow position by a series of release treatments. (7). Such treatments will increase the proportion of paper birch in the stand and will accelerate and concentrate the growth on the most desirable trees.

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Effects of FERTILIZER-NUTRIENT INTERACTIONS on Red Oak Seedling Growth

by L. R. Auchmoody

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Effects of FERTILIZER-NUTRIENT INTERACTIONS on Red Oak Seedling Growth

GROWTH of red oak seedlings was examined in relationship to various levels of nitrogen (N), phosphorus (P), and potassium (K) supplied singly and in all combinations to forest soils from the Barbour series. Results showed that seedling growth was significantly affected by NxP and NxPxK interactions; and that, without nitrogen, P and K alone or in combination with each other did not increase growth. These findings suggest that NxP and NxPxK interactions should be considered in designing fertilization tests on soils that have P and K levels similar to or lower than those tested in this study.

Soils vary in their ability to supply nutrients for tree growth. Forest stands on some soils do not respond to fertilization because nutrient levels are adequate or because growth is controlled by physical limitations such as moisture supply and rooting depth.

Growth response to fertilization can also be drastically reduced or completely eliminated in situations where more than one nutrient is deficient, if each deficiency is not corrected by fertilization. Furthermore, when the supply of a critically low plant nutrient is increased by fertilization, plant requirements for other essential nutrients can rise, and minimal supplies of these nutrients in the soil that were not limiting growth before fertilization can sometimes become deficient and limit growth after fertilization. Several studies have indicated the importance of nutrient interactions on growth of upland hardwoods *(1, 2, 3)*. These studies have shown greater response from simultaneous application of two fertilizer nutrients than from either of the nutrients applied alone.

METHODS

The experiment was designed as a 3^3 factorial (N, P, and K at three levels) in randomized complete blocks with three replications. It was conducted indoors with seedlings grown in gallon-size plastic pots.

Soil from the Barbour series was collected from a 6-inch section of the profile located just beneath the A_1 horizon. Barbour soils have developed from deep, well-drained, moderately coarse-textured alluvium on flood plains. Samples were obtained from three independent locations supporting vigorous and well-stocked stands of yellow-poplar (*Liriodendron tulipifera* L.). Each pot contained approximately 9½ pounds of oven-dry soil. Nutrient characteristics are given in table 1.

Table 1.—*pH and nutrient status of the study soils*[1]

Replication	pH	Total N	P	K	Ca	Mg
		Percent		*Pounds/acre*		
I	4.6	0.029	14	38	109	18
II	4.6	0.039	8	51	141	24
III	4.5	0.043	8	32	106	14

[1]pH by glass electrode in 1:1 soil/water solution; total N by Kjeldahl digestion; P colorimetrically after extraction by .002 *N* H_2SO_4; K, Ca, and Mg by atomic absorption after extraction with NH_4OA_c.

Red oak (*Quercus rubra* L.) seedlings were germinated from uniform-size acorns in sterile sand. Three seedlings of equal size were transplanted into each pot, and after 3 weeks the poorest of the three was removed. The seedlings were grown under a 20-hour photoperiod, with light supplied from a combination of fluorescent and incandescent lamps. Light intensity was maintained at about 1,000 foot-candles near the tops of the seedlings. Soil moisture was brought to field capacity daily with distilled water.

Nutrient treatments included all combinations of three levels of N, P, and K. Nitrogen rates corresponded to 0, 200, and 400 pounds per acre and P and K rates to 0, 100, and 200 pounds per acre. Solutions containing N, P, and K were prepared from reagent grade NH_4NO_3, NaH_2PO_4, and KCl, and these were applied to the seedlings in two equal doses at 14 and 21 days after start of the experiment.

After 91 days the study was terminated. Seedling height was recorded, and plants were dried at 70° C. for determination of top and root weights.

RESULTS

Nitrogen alone significantly (0.01 level) increased seedling height and top dry weight, but had negative effects upon root production (table 2). Nitrogen rates corresponding to 200 pounds per acre usually resulted in one extra flush in height growth while 400 pounds per acre resulted in two and sometimes three extra flushes as compared to seedlings not treated with N.

Phosphorus alone had little effect on seedling height or top dry weight, but had a tendency to depress root dry weight at the 200-pounds-per-acre rate.

Potassium by itself did not significantly (0.05 level) affect height, top dry weight, or root dry weight at residual soil levels of N and P. Plants receiving K varied little in color, height, or weight from seedlings in check treatments.

N and P applied simultaneously had strikingly greater effects upon seedling height and top dry weight than individual applications of N or P (figs. 1 and 2). The data show that

Table 2.—*Effect of N fertilization on height, top dry weight, and root dry weight of red oak seedlings*

N rate	Height		Top dry weight		Root dry weight	
Pounds/acre	*Inches*	*Pct. gain**	*Grams*	*Pct. gain*	*Grams*	*Pct. gain*
0	5.12	—	1.58	—	1.93	—
200	6.33	24	2.19	38	1.73	−11
400	9.36	82	2.69	70	1.51	−22

*Percentage gain over unfertilized seedlings.

Figure 1.—Simultaneous effects of nitrogen and phosphorus upon height growth of red oak seedlings.

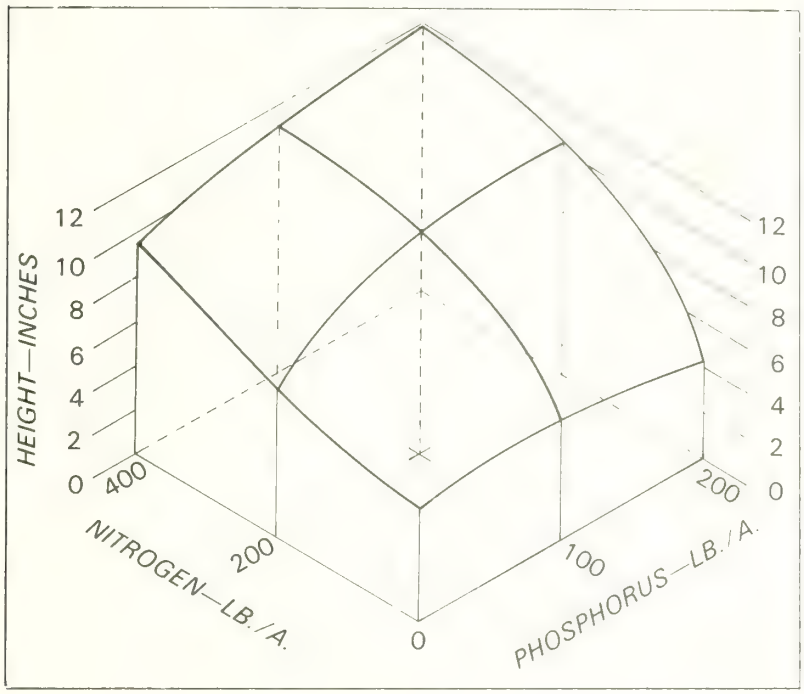


Figure 2.—Simultaneous effects of nitrogen and phosphorus upon top dry weight of red oak seedlings.

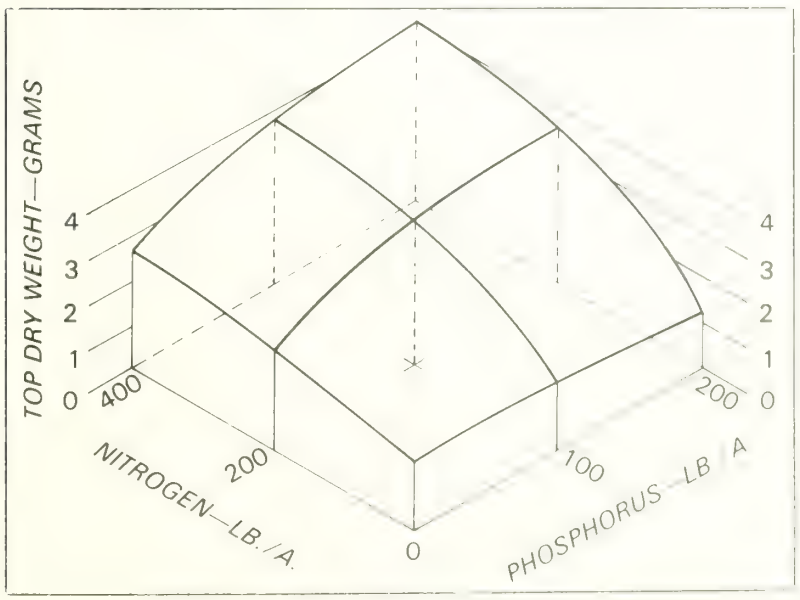
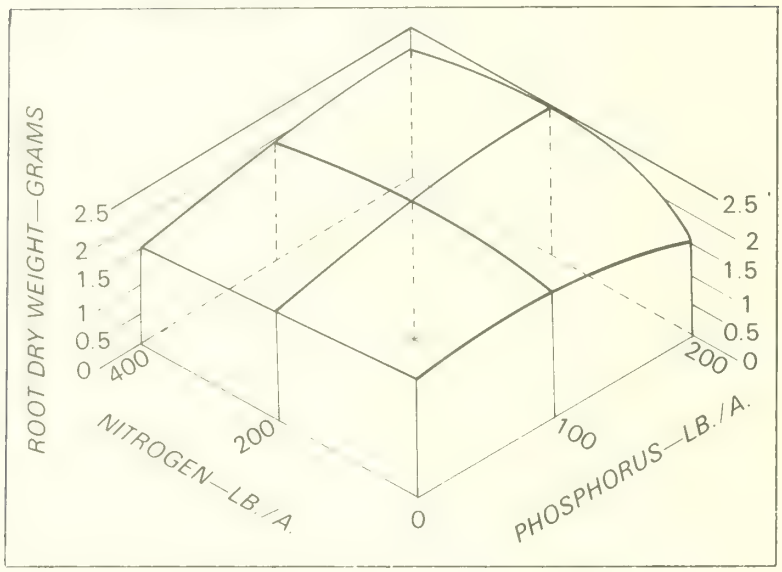


Figure 3.—Simultaneous effects of nitrogen and phosphorus upon root dry weight of red oak seedlings.



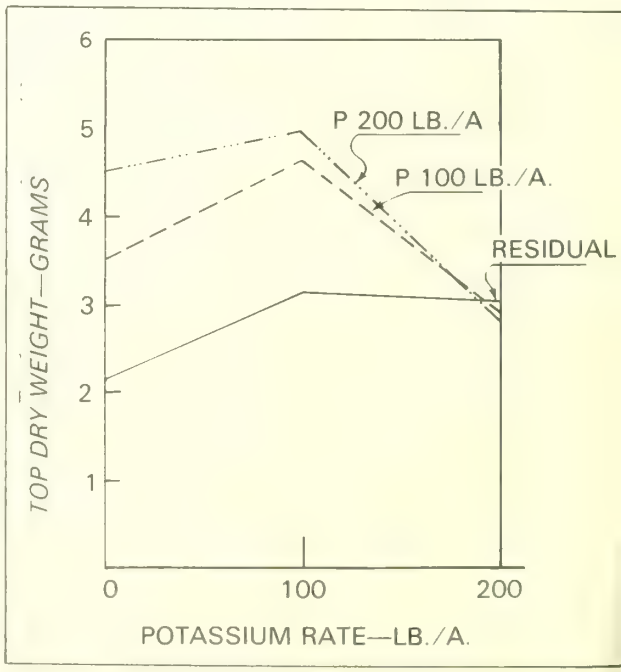
height and top dry weight were initially limited by N deficiency. As N supply was increased, plant requirements for P also increased, and potential yields were limited by lack of available P in the soil.

Root growth was reduced by individual applications of N and P, but was increased when both nutrients were applied together (fig. 3). Phosphorus promoted root activity at both rates of N, but the best production occurred when both elements were supplied at rates of 200 pounds per acre. At N rates of 400 pounds per acre, root response to P was less than at the 200-pounds-per-acre rate.

Potassium in combination with 400 pounds per acre of N significantly (0.05 level) increased top dry weight when it was applied at 100 pounds per acre, but it decreased top weight when it was applied at 200 pounds per acre. The response varied with rate of P fertilization (fig. 4). Potassium in combination with either N or P did not significantly (0.05 level) affect seedling height or root dry weight.

Maximum top dry weight production occurred at rates of 400 pounds per acre of N and 200 pounds per acre of P in combination with 100 pounds per acre of K. Seedlings fertilized at this rate were 227 percent heavier than unfertilized control seedlings. Nitrogen alone accounted for 34 percent of this re-

Figure 4.—Effects of potassium on top dry weight of red oak seedlings supplied with 400 pounds per acre of nitrogen for three levels of phosphorus.



sponse, P in combination with N for 53 percent, and 13 percent was due to K.

Maximum seedling height occurred at rates of 400 pounds per acre of N and 200 pounds per acre of P. Seedlings fertilized at these rates were 129 percent taller than unfertilized control seedlings. Nitrogen alone produced 65 percent of this response, and P in combination with N the remaining 35 percent.

DISCUSSION

The favorable growth response resulting from simultaneous application of N, P, and K over that obtained with either element alone, strongly suggests that nutrient interactions should be considered in designing forest fertilization field tests. Failure to consider these interactions may lead to the erroneous conclusion that nutrients are not limiting growth when they actually are, or to serious underestimates of potential response if there is an additional nutrient deficiency not corrected by fertilization.

The data suggest that growth response to P in acid soils is possible at levels ranging from 8 to 14 pounds per acre and below when N is not limiting. A small response to K when applied in combination with N and P, may also be forthcoming when the soils contain about 50 pounds per acre or less of exchangeable K. However, because these results were developed from seedlings grown in pots in a greenhouse environment, they are subject to a number of limitations; and caution must be exercised in extrapolating to field conditions.

We are uncertain whether P and K levels of the study soils accurately estimate soil-nutrient levels under which a field response to fertilization would be forthcoming. These levels may be considerably below critical concentrations for fast-growing, nutrient-demanding species such as yellow-poplar or above critical levels for slow-growing, low-nutrient demanding species such as chestnut oak (*Quercus prinus* L.).

Moreover, critical soil-nutrient levels may be influenced considerably by the volume of soil on different sites from which nutrients can be absorbed. Until better estimates of plant nutrient requirements become available, fertilization tests with soil having P and K contents similar to those reported in this study should include treatments to evaluate NxP and NxPxK interactions if valid estimates of growth response are to be achieved.

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Installing PLASTIC TUBING to collect SUGAR MAPLE SAP

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by H. Clay Smith
and Albert G. Snow, Jr.

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COVER PHOTO: Off into the sugarbush, shod with snowshoes and festooned with tubing and tools for setting up the sap-collecting system.

IN THE LATE 1950's and early 1960's, maple syrup producers began using plastic tubing to collect maple sap for processing into maple syrup. At first, tubing was thought to be a neat solution to the problem of high cost in collecting maple sap. Although many producers did have excellent results with tubing, a large number could not make it work. Lack of success led these producers to quit using tubing and return to the traditional sap bucket.

Today there is much renewed interest in plastic tubing, due primarily to the success that many producers have had. Much information is now available about use of tubing. Plastic tubing *will* work on many sugaring operations.

The research unit of the Northeastern Forest Experiment Station at Burlington, Vermont, has been doing research on methods of installing tubing since 1966. We have studied several ways of hanging tubing and have found that there are certain techniques to use if plastic tubing is to be installed and to operate successfully.

The movement of sap through a tubing system can be compared to a number of small streams flowing together and into a reservoir. In a sugarbush, tubing is installed so that the sap from a number of trees can flow into a collecting tank (fig. 1).

Figure 1.—Schematic design for a plastic-tubing sap-collecting system.

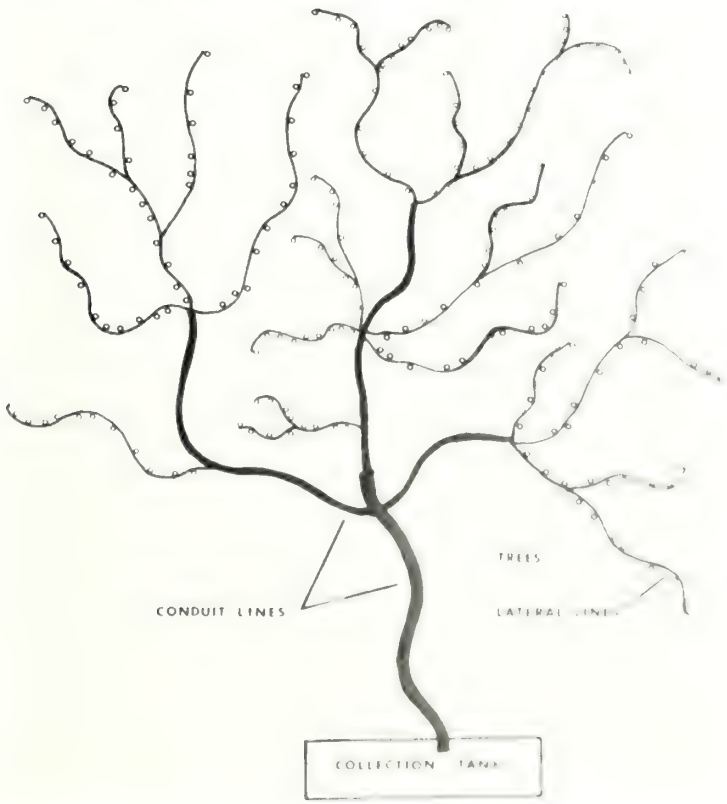
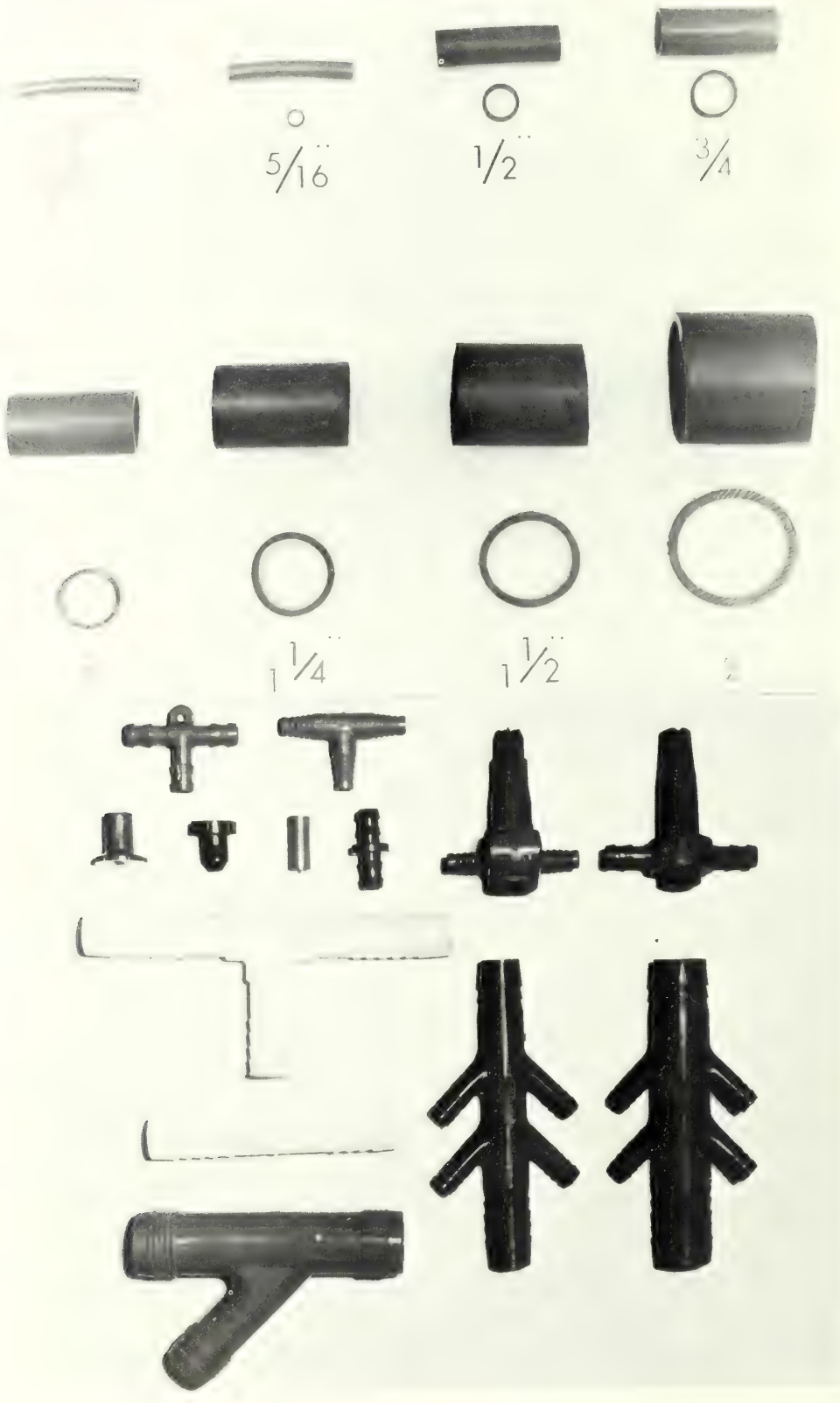


Figure 2.—Top, typical sizes of tubing used in a sap-collection system. Bottom, fittings used to join tubing.



Lateral lines of small tubing (1/4 inch to 5/16 inch) are used to collect the sap from the trees. These small lines lead into larger conduit lines (3/4 inch to 1-1/2 inches), which carry the sap down to collecting tanks. Progressively larger tubing is used in the lower stretches of the conduit lines to carry the greater flow (fig. 2).

Make sure that the tubing you use is large enough to carry the greatest flow. Each drop of sap must have a place to go. During periods of good sap flow, a small tubing line may receive more sap than it can carry. When a line becomes overloaded, some of the sap may be lost. Though this may happen only a few times in a season, plan to avoid it.

TUBING SYSTEMS

Maple syrup producers use many combinations of tubing, but basically tubing is installed in one of two ways. Tubing may be hung in the air from tree to tree (an aerial line) or placed on the ground (a ground line). With either type of installation, the most important factor for success is that the tubing must have sufficient slope for the sap to flow by gravity to a collection tank.

If the topography of the sugarbush is steep, installing tubing so it slopes downhill is relatively easy. However, when the topography is nearly flat, installing tubing successfully can be a nightmare. On flat land, you must carefully survey the heights of your tapholes and tubing lines to be certain that the lines slope down as much as possible. An artificial vacuum can be applied to the tubing installation to draw the sap through the lines *(Morrow and Gibbs 1969)*.

In many early tubing installations, the lateral lines were connected directly from spout to spout. This proved unsatisfactory because sap was often lost through reabsorption or bad tapholes. Droplines (fig. 3) attached to the spouts prevent this sap loss by carrying the sap away from the taphole. This technique is used by most producers.

Aerial System

In the aerial system, the lateral tubing is usually hung 2 to 4 feet above the ground or snow level. With aerial lines, 18- to 24-inch droplines are generally used. If shorter drop-

Figure 3.—Spout droplines. Left: an 18-inch aerial-line dropline. Right: a 4-foot ground-line drop. The small lateral-tubing lines are parallel to the ground.

Figure 4.—Snow problems. Left: how snow accumulates on aerial lines; snow has been removed from the lower line. Right: the ground-line tubing is buried under the snow.

lines are used, there is little leeway for moving the dropline to an untapped area on the tree when the tubing is re-installed another year. If droplines longer than 24 inches are used, the installation approaches that of a ground-line setup. Some producers used both 18- and 24-inch droplines on the same line to reach new areas of the tree when tapping in later years.

There are both advantages and disadvantages in using an aerial line for collecting sap. The advantages:

1. Minimum freezing problems because most of these lines are above the snow.
2. The slope of the tubing line is easier to control.
3. A minimum amount of tubing is used per taphole.
4. Problem areas are easier to locate and correct.
5. Tubing can be used on nearly flat areas because slope of line can be regulated to a degree by height of tapping. However, this is difficult to do, especially for a sugar producer who has little experience in installing tubing.

The disadvantages of aerial lines:

1. They are harder to install than ground lines. To install the tubing properly, it should be stretched. Even after stretching, new tubing may develop sags. If the tubing is stretched too tightly, it may separate from the tubing fittings.
2. If the distance between trees is great—say 30 feet—the tubing may have to be supported to minimize sagging.
3. In some instances, freezing rain, ice, or wet snow can collect on the lines and cause damage (fig. 4).
4. Falling branches may cause damage and leaks; and animals and people may also damage the lines.

Ground-Line System

In the ground-line system, the tubing is placed on the ground or on top of the snow. Usually no attempt is made to slope the tubing because it follows the lie of the land.

Spout droplines are 4 to 4-1/2 feet long. The tapholes are drilled at a height of about

5 feet above the ground, and the dropline is attached to the lateral lines.

Although there may be advantages to using ground lines, in our opinion these are overshadowed by the snow and ice problems. If snow accumulation is high, it is risky and costly to use a ground line. The lines must be pulled free from the snow periodically (fig. 4). If this is not done, sap will freeze in the tubing; and when sap flow begins, the snow, acting as an insulator, delays the thawing process. Considerable sap can be lost.

If snow is not a problem, there are advantages to using ground lines:

1. The ground lines are easier to install than aerial lines, for they do not have to be stretched when hung.
2. Since longer spout droplines are used, retapping is easier because this extra length allows the spout to be moved to an untapped part of the bole.
3. If the tubing is disassembled and reinstalled, it does not require the same exact layout. An extra foot of loosely installed tubing on the ground is of little concern to the sugar producer.

There are several disadvantages other than pulling the lines from the snow:

1. More tubing is used per spout because of the longer droplines and the fact that the tubing is not stretched from tree to tree.
2. If the area has a lot of potholes or undulating topography, the sap inside the tubing may collect in low spots and freeze. This can block sap movement through the lines.
3. Sap that collects in low spots can spoil, and it may contaminate sap in the next sap run.
4. Leaks are difficult to find and repair, particularly in snow.

Figure 5.—Examine the area before hanging the tubing.

5. This method is very poorly suited to flat land, because there is no control over tubing slope.

INSTALLATION

Plan the System

Before installing any lines, decide which tubing method to use—aerial line or ground line. Use the method that you are confident will be successful for you.

Before installing tubing, consult producers who have experience with tubing. A mistake many producers make when they are using tubing for the first time is to try to install tubing on a large area. It is better to start with 50 tapholes and learn the techniques before trying larger operations.

The first time tubing is installed on a new area is critical. All major changes should be made as soon as possible because later changes may be difficult and costly. Initial planning and experience with tubing are very important.

Examine the Area

It is important to know the general topography of the sugarbush area. In general, the steeper the slope, the better the area is for tubing. First count the number of maple trees, by tree diameter class, in the area. This will give you an idea of tree spacing and the number of tapholes to drill. Study the general slope of the area and determine where the large conduit tubing should be placed so that all the trees can be tapped and the tubing lines can be connected to a central point—the collecting tanks (fig. 5).

Install Conduit Lines

The conduit tubing lines (1/2 inch and larger) can be installed a few months before the sap season begins—in summer or fall. Many syrup producers have these lines installed permanently. If this is done, the lines should be plugged to keep foreign objects out, and should be flushed clean before being put into use again.

Bear in mind that tubing installed early is subject to damage from falling limbs, weather, animals, and people (hunters, snowmobiles, etc.). Most tubing is placed between November and March.

Conduit lines can be installed on the ground surface, under the ground, or suspended above the ground. We think that aerial conduit lines are best, because freezing and thawing are minimized. Placing tubing on the ground presents problems because, when the lines are covered with snow, the sap in the line may freeze and will be slow to thaw. Placing tubing under the ground keeps the sap cooler, minimizes freezing, and prevents rodent damage; but if a leak develops, it is hard to find.

The conduit lines must, above all, have a slope so that the sap will flow through them by gravity. The tubing must be large enough to carry the greatest sap flow.

Install Lateral Lines

The smaller lateral lines can also be partially installed—placed but not connected—before the sap season begins. As with any tubing placed early, there is risk of damage.

We place lateral lines by working down from the top of the hill to the bottom. We try to have about 20 tapholes on each lateral line. However, for trees that are notably high sap producers and are growing on gently sloping land, you should use fewer tapholes per lateral line.

The following instructions are for an aerial line system (fig. 6).

Begin with a roll of tubing (usually 500 feet long). Start at the top of the sugarbush. Tie one end of the tubing around the uppermost tree. Then lead the tubing down the slope, from one tapable tree to the next. Pull the tubing tight as you go, so the pressure holds it in place against the tree stem.

Keep the slope of the line as uniform as you can.

Keep the line as straight as you can, with a minimum of turns. The straighter the line, the faster the sap will flow through the tubing. Use as few connectors as possible, because each fitting is a potential source of leak.

At the bottom of the line, near where it will connect into the conduit line, tie the tubing to a tree. Keep the tubing tight to maintain the slope of the line.

Re-examine the line to make sure that it has a downward slope in all sections, so that the sap can move down the tubing by the pull of gravity. If some parts of the line do not have downward slope, adjust the line till they do.

At this point, you have established the general pattern of the line.

Figure 6.—The difference in installation between an aerial line and a ground line. Left: the lateral tubing of the aerial line is strung tightly from tree to tree. Right: the ground line lies loosely on the ground.

Tap the Trees

After the lateral lines have been placed, you are ready to tap the trees. The first step is to determine the position for the tapholes.

Never drill a taphole above or below an old visible taphole or taphole scar. For best results, drill tapholes in sound, unstained wood. Stained wood may not always be unproductive; however, wood that is dry or very dark indicates decayed tissue and should not be tapped.

Most producers prefer to drill tapholes on the south side of the tree, but this is not always convenient. In most cases, it is more important to have the tubing supported by the tree bole than to drill all tapholes on the south side of the tree.

Use the dropline to measure the height of the taphole above the lateral tubing line (fig. 7). This keeps the lines at approximately the same slope and minimizes line sagging after the lines fill with sap. Tapholes are normally 4 to 6 feet above the ground; of course, this height varies with snow depth and the height of the person tapping.

Several types of tappers are used to drill tapholes, including gasoline-, battery-, and hand-operated tappers (fig. 8). Standard tapholes are 7/16-inch in diameter. Larger holes have been tried, but did not increase the sap yields *(Robbins 1968)*.

Figure 7.—The dropline is used to determine the height of the taphole above the lateral line.

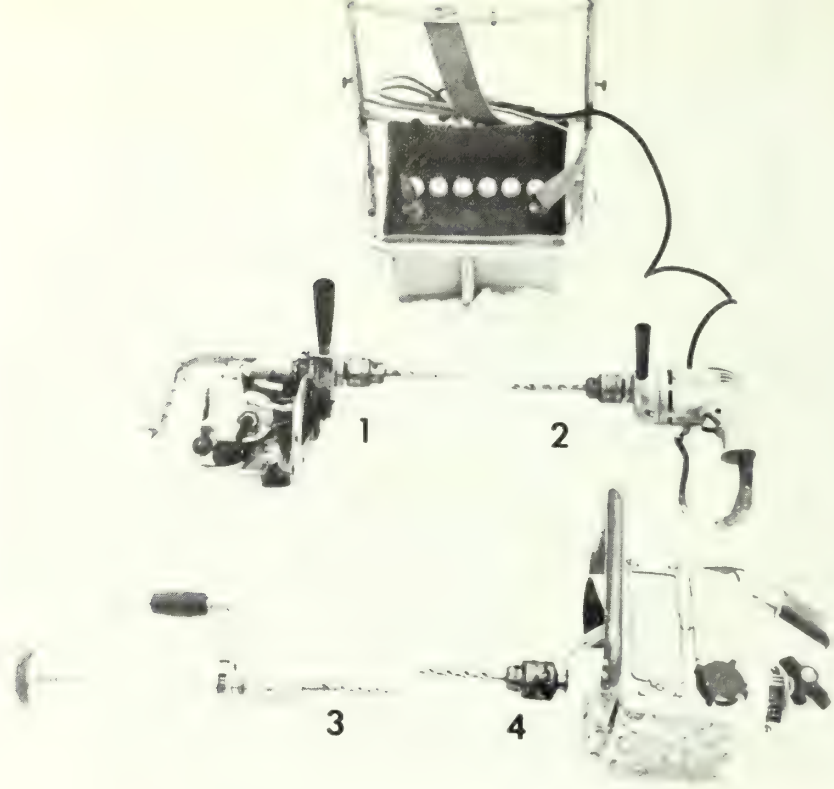


Figure 8.—Tapping equipment. 1, a gasoline-powered drill. 2, a battery-powered electric tapper. 3, a hand auger. 4, another type of gasoline-powered drill.

Drill the tapholes at a slightly upward angle, so the sap will flow easily out of the hole. Hold the tapper very steady in drilling, so that the hole is clean and round (fig. 9). An unsteady hand on the drill may produce holes that are oval rather than round; and spouts do not fit snugly into oval holes; then leaks occur.

Drill tapholes to a wood depth of 3 inches, excluding bark. However, if the tree has considerable rot or appears to be hollow, tapholes should not be so deep. For poor trees, drill tapholes to a wood depth of 2 to 2-1/2 inches.

Hammer the spout—with dropline attached—into the taphole (fig. 10). Be careful not to drive the spout in too hard. There is a definite sound or feeling that indicates when the spout is seated well. If the spout is driven too deep, the bark may split, particularly on a cold day. If the bark is split, there is a possibility for leaks and invasion of the tree tissue by decay organisms.

Figure 9.—Using a gasoline-powered tapper to drill the taphole.

Figure 10.—Driving the spout—with dropline attached—into the taphole.

Check for Leaks

After attaching the spout dropline to the taphole, check the dropline and taphole for leaks. One way to do this is to suck on the dropline (fig. 11). If you suck air, you know that there is a leak somewhere. However, checking each spout dropline and taphole does not always guarantee a leakproof installation. For example, in a hollow tree, a plug of ice may make the taphole seem sound when it isn't; and later sap may be lost by leaking down inside the tree.

After the tubing has been installed, it is difficult to find leaks. If unvented spouts are used, you can attach a vacuum pump to the tubing installation and check systematically when the temperatures are above freezing.

Once the spout droplines and tapholes have been checked for leaks, you are ready to attach the droplines to the lateral tubing line.

At the first spout at the top of each lateral tubing line, the dropline tee is usually attached to the tree (fig. 12). Use a nail or string to anchor this first dropline tee and reduce stress on the plastic fittings. U-shaped staples may also be used. This is normally

Figure 11.—One way to check the dropline for leaks: suck on it.

Figure 12.—At the uppermost tree in the sugarbush, the end of the lateral line is secured to the tree with a small nail through the tee. Note that one end of the tee is capped.

Figure 13.—Sometimes—if there will not be much strain on the join, the lateral line can be fastened directly to the spout.

done only at the uppermost spout dropline of each lateral line.

Some producers, instead of using a dropline for the first upper spout, attach the lateral line directly to the spout (fig. 13). The bottom of the spout is twisted at an angle so that the tubing is not crimped.

Join Droplines To Lateral Lines

Before joining the lines, stretch the tubing between the two trees (fig. 14). Stretching is especially necessary for new tubing.

If the tubing has been used in previous years and is being re-installed, you do not need to stretch it as tightly as new tubing. Stretching it too tightly might pull the tees out of position in relation to the trees; then later you might have to cut the tubing and

Figure 14.—Stretching the lateral tubing.

add extra tubing and connectors to adjust the line.

To attach a dropline to a lateral line, cut the lateral line and fit the two cut ends onto the tee at the end of the dropline (fig. 15).

If the tubing is cold and stiff, it may not fit easily onto the tee. Warm it. You can use a small portable heater to warm a small pot of water; placed in the hot water, the ends of the tubing will soften quickly. Other types of heaters—such as hand-warmers—are also used. Some people use cigarette lighters, but this kind of heat may distort the tubing ends so they do not make a good joint on the tee. Some people say that the simplest way is to put the end of the tubing in your mouth and chew on it till it softens.

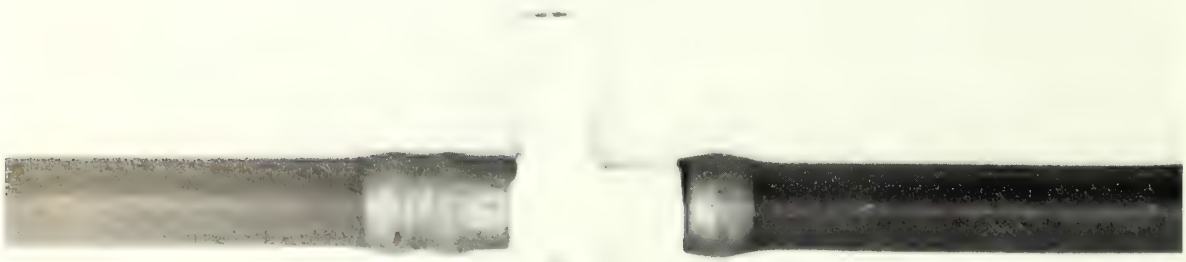
We have also used a tubing spreader—automobile brake-piston needle-nose pliers—to spread the tubing (fig. 16).

Be sure to push the tubing all the way onto the fitting (fig. 17). This reduces the possibility of leaks around the fitting and keeps the tubing from pulling off when tightly hung. Small tubing clamps may be used to get a secure joint.

Figure 15.—Joining the dropline into the lateral tubing line. The lateral line is cut, and the tubing ends are fitted onto the tee at the end of the dropline.

Figure 16.—Needle-nose pliers can also be used to spread the tubing before fitting it onto the tee.

Figure 17.—Make sure the tubing is fitted completely onto the tee. The joint at the right probably will not hold. Small hose clamps can be used to get a secure joint.



Join Lateral Lines To Conduit Line

After the desired number of tapholes have been connected to the lateral line, connect the lateral line to the larger conduit line. Conduit tees fit into the conduit line are commonly used for making the joints (fig. 18).

There is another way, which we call "the Swayze method", for connecting lateral lines to the conduit lines (fig. 19). A small drill bit is used to drill a hole into the top of the conduit line. The hole should be slightly smaller than the tee-cap fitting; use about a 19/32-inch drill for 5/16-inch fittings. A hole punch is sometimes used to ream the hole. Then insert into the drill hole a lateral tubing tee with a cap that has the end cut off. The cap acts as a gasket or bushing. If done properly, the fitting does not leak; but applying plastic cement to the fitting assures a better seal.

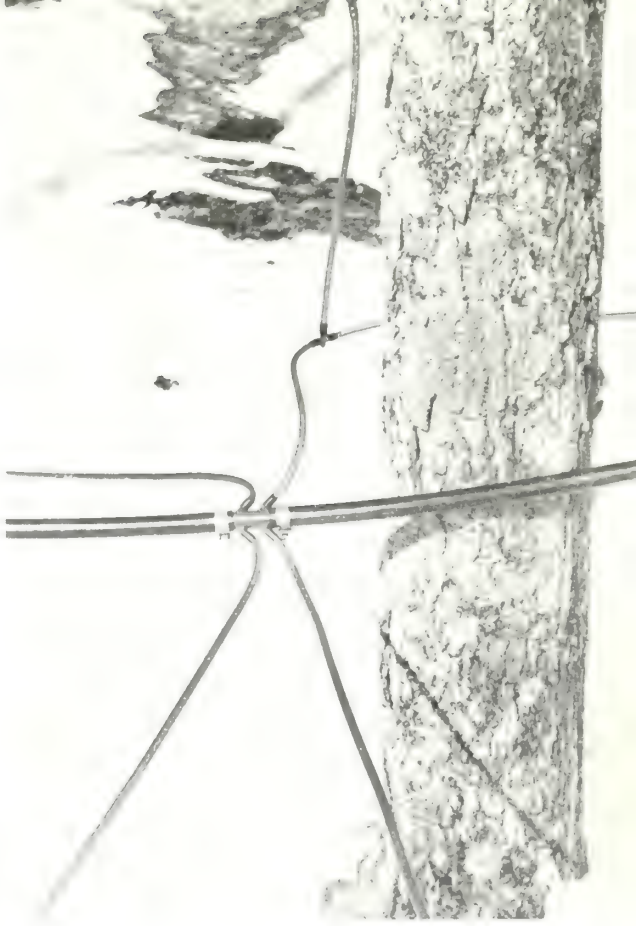


Figure 18.—Joining lateral lines to the larger conduit line. Here a 4-way connector is used to lead four lateral lines into the conduit line.

Figure 19.—Another way to join a lateral line to a conduit line. In this "Swayze method", a hole is drilled into the conduit line, and the lateral line is joined into it with a capped tee.

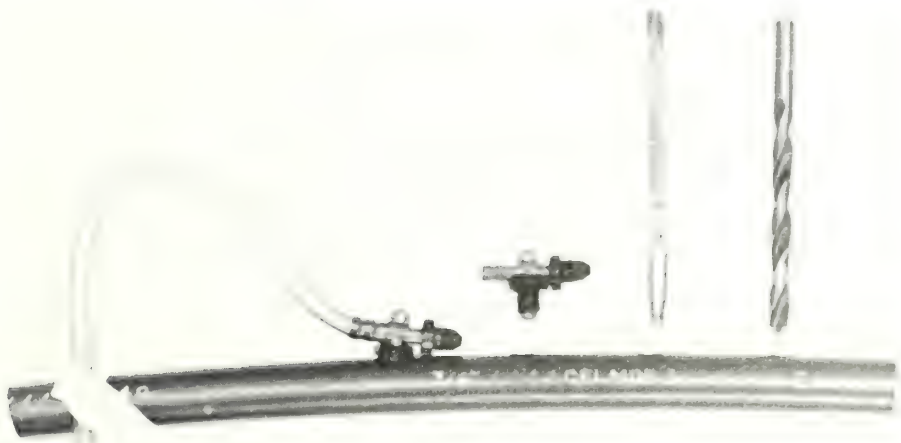


Figure 20.—Completed lines. Left: an aerial line. Right: a ground line. Notice that in both of these lines a lateral branch has been joined into the main line.

Ground Lines

The above instructions are for an aerial system. The procedure for installing a ground-line system is in general the same. The only difference is that longer droplines are used, and the lateral lines are laid loosely on the ground rather than stretched from tree to tree (fig. 20).

OTHER CONSIDERATIONS

Adding Extra Lines

Other groups of trees can be added to an existing sap-collecting system by cutting a new branch line into the lateral line (fig. 20.)

More than One Taphole per Tree

If more than one taphole is drilled into the same tree, there are several ways to connect the additional tapholes into the tubing system. One obvious way is to run the lateral line completely around the tree, cut it, and install a tee on each dropline.

Another way is to run the lateral line past the trees, as is normally done for a single taphole tree, then connect one spout dropline to the other (fig. 21). Of course, droplines of different length should be used, or the height of the tapholes should be varied so that the sap will flow by gravity to the tee on the drop-

Figure 21.—One way to join two ta holes on a tree to the lateral line: a dropline is joined to the other dropli You could also join droplines directly to t lateral line.

line. When this technique is used, only one tee is attached to the lateral line.

Size of Fittings

For very tight tubing systems, you can use 5/16-inch fittings with 1/4-inch tubing. We have found that this technique works satisfactorily.

Spout Venting

Several research studies have shown that tubing installations with unvented or capped spouts will produce more sap than tubing with vented spouts (fig. 22). The main reason for this increase in sap yield is a natural vacuum that develops in the tubing lines, resulting primarily from the weight of the sap as it moves through these lines *(Blum 1967)*.

Supporting the Tubing

In some sugarbushes, the trees are widely spaced. If an aerial-line tubing installation is used, the distance between trees may be so great that the tubing will sag nearly to the ground even though it is stretched tightly. It is advisable to support long spans of aerial tubing by using wire, string, wooden or metal props, tree saplings, etc. (fig. 23). Supporting will reduce tension on tubing fittings, minimize sagging, maintain tubing slope, and keep the aerial line in the air.

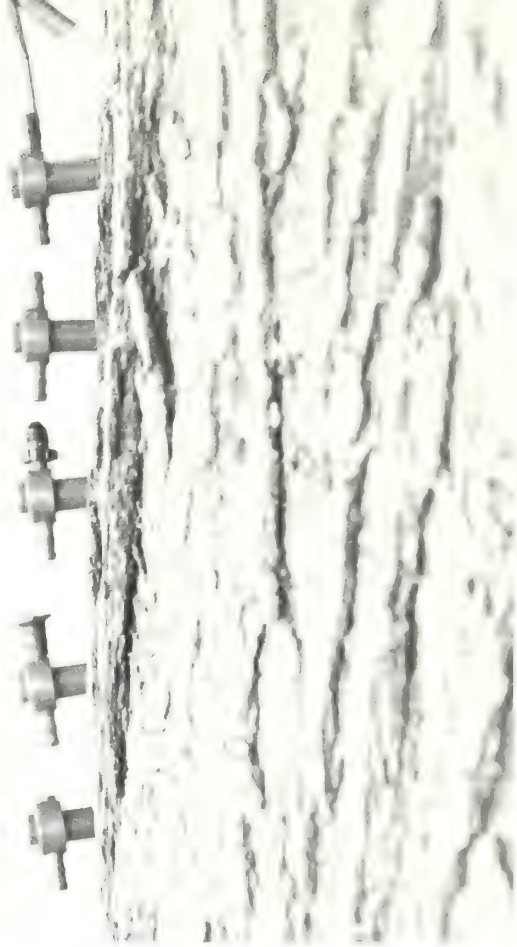


Figure 22.—Different types of spouts used with plastic tubing. The upper two spouts are vented. The lower three are unvented.

Figure 23.—If the distance between trees is so great that tubing will sag badly, the tubing should be supported.

Coding

After the tubing is hung, the trees and tubing should be marked or coded so that the tubing can be re-installed in the same position next year. With proper coding, the tubing can be re-used for several years.

You can mark the trees with paint or tags or plastic tape of different colors. Mark the upper and lower ends of tubing lines the same way. Usually each lateral tubing line that is connected to the conduit line is coded to the conduit fitting.

The spout droplines may be disconnected from these lateral lines, but the dropline tees usually remain in the lines. A sketch map of the tubing area, showing the location of tubing lines, is very helpful when the tubing is re-installed.

Leaks

Check the tubing installation periodically for leaks and damage and blockage. Sometimes tubing can be stretched too tight; and on warm days during a sap flow, the tubing may separate from the fittings.

A number of other circumstances can cause leaks. Sometimes lines are not connected securely during the initial tubing installation. Fittings may be cracked or broken. Rodents may gnaw holes or slits in the tubing (fig. 24). People may damage lines. Heavy snow or ice may tear a line down.

Let Tubing Hang?

Some producers leave their conduit lines hanging in the sugarbush from season to season. A few also leave their lateral tubing in place. If the lateral tubing is left hanging, a pressure pump or hand backpump should be used to flush the lines with a cleaning solution.

When spouts are removed from the taphole, both vent and spout and end should be capped. The tubing may then be left hanging until the next sap season. Assuming that the lateral tubing is clean and there is no severe damage from rodents and people, it may be economically desirable to leave all tubing installed in place from year to year. Try this on a small-scale basis before you try it on your whole operation.

Use of the Pellet

Many maple syrup producers insert a small aspirin-size pill—a paraformaldehyde pellet—in each taphole to prolong sap flow and increase sap yields. The University of Vermont, the Vermont Department of Forests and Parks, and the Northeastern Forest Experiment Station are cooperating to study the effect of the pellet on the woody tissue surrounding the taphole *(Shigo and Laing 1970; Smith et al. 1970)*.

Figure 24.—Typical damage done to tubing installation by rodents (rabbits? squirrels? mice?).

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by Martin E Dale

Growth and Yield Predictions for Upland Oak Stands

10 Years After Initial Thinning

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Growth and Yield Predictions for Upland Oak Stands

10 Years After Initial Thinning

THE OAK-HICKORY forest type is by far the most extensive hardwood timber type in this country. It occupies nearly 116 million acres, or about one-quarter of the commercial forest land in the United States. Although this timber type dominates the forest landscape from the Appalachian Mountains west to the Great Plains, we have little information about either the quantitative or qualitative growth and yield of thinned upland oak stands.

This seriously handicaps intensive timber management because such information is necessary for selecting from among various thinning alternatives the one practice best suited to meet a specific objective. Three types of information are needed for selecting the best alternative: (1) the change in physical yields resulting from a specific thinning practice, including quantity, quality, and timing of yields; (2) the costs incurred in applying the practice; and (3) the values of the physical yields when they occur. With such estimates the decision-maker can select objectively among alternatives, determine the relative profitability of each, and assign priorities for stand treatment.

The purpose of this paper is to furnish part of the needed information, that is, quantitative estimates of growth and yield 10 years after initial thinning of upland oak stands. All estimates are computed from a system of equations. These predictions are presented here in tabular form for convenient visual inspection of growth and yield trends. The tables show growth and yield in terms of basal area, total cubic-foot volume, cordwood volume, and board-foot volume over a broad range of site, age, and residual stand density classes.

All the equations were developed from a set of 154 permanent growth plots where responses were observed over 5- to 12-year growth periods. Many users with access to computers will find the equations more useful than tables, especially if interested in specific stand conditions not listed in the tables or for use in other computer programs. A complete

discussion of equation development is beyond the scope of this paper; however, the basic regression equations are given in the Appendix.

The 154 permanent plots used in developing the growth and yield predictions were established as part of eight separate growth studies, two each in Kentucky, Ohio, Missouri, and Iowa (fig. 1 and table 1). All eight groups of plots were analyzed together because the objectives, methods of treatment, and plot-selection criteria were essentially the same.

Species composition varied between series from white oak to almost pure black oak stands (table 2). Although species composition does affect growth and yield, species differences are ignored in this report. Our plot data indicated confounding between species and location, and between species and site quality; so with our sample there was insufficient plot data for separating out species effect.

Stand age at time of initial thinning varied among the growth series from 22 to 90 years, which should adequately cover ages where intermediate cutting is practiced. Site index of plots averaged 69 overall, varying from 55 to 89; but most plots (83 percent) ranged between site indexes 60 and 80. Site index was based upon Schnur's (*1937*) site-index curves for upland oak. Our distribution of sample plots by site index is typical over a large part of the natural range of upland oak.

All plots were chosen initially as representative of fully stocked even-aged upland oak stands that showed little evidence of recent fire or logging. On some plots a few older and larger trees were present, probably as holdovers from the previous stand. Site index and

Figure 1.—Location of the study plots.

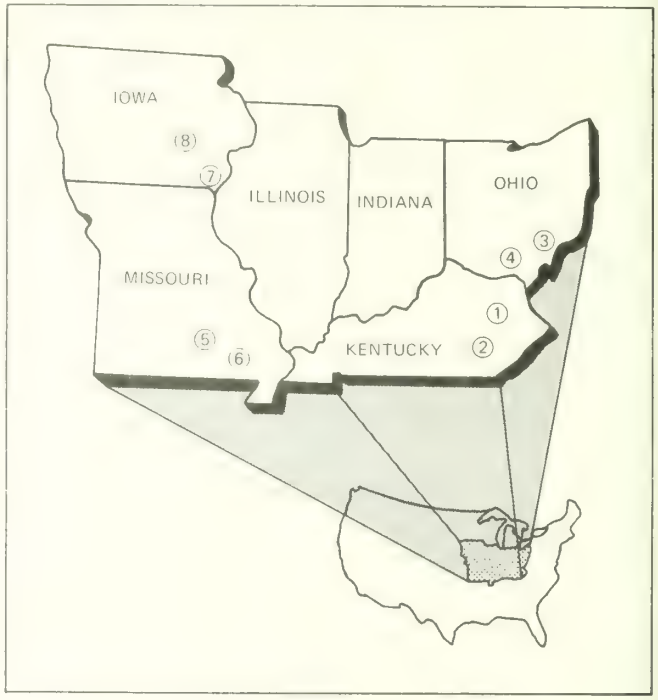

Table 1.—*Characteristics of studies used to develop growth and yield relations for upland oak*

Study No.	Location	Plots	Plot size	Date study started	Initial average stand age	Range of site index	Re-measurements	Years of growth used in computing average	Principal species
		No.	*Acres*		*Years*		*No.*	*Years*	
1	Kentucky	[1]6	0.5	1961	33	62-77	7	7	White oak
2	Kentucky	16	1.0	1959	80	60-68	7	7	White oak
3	Ohio	16	.5	1961	31	67-80	7	7	Mixed oak
4	Ohio	16	.5	1962	60	60-71	6	6	White oak
5	Missouri	30	.5	1962	22	61-89	1	5	Black oak
6	Missouri	30	.5	1961	40	60-84	1	6	Black oak
7	Iowa	20	.2	1949	25	55-66	5	[2]12	White oak
8	Iowa	20	1.0	1953	90	60-69	6	9	White oak

[1]Nine additional plots cut to lower density levels were eliminated from analysis because all understory stems were cut.

[2]This series received a second thinning in 1961, but response to only the first thinning is included.

Table 2.—*Basal area and number of trees for each study at beginning and ending of growth period, by species groups*[1]

[In percent]

Study No.	Date	Group 1		Group 2		Group 3		Group 4		Group 5	
		No. trees	Basal area	No. trees	Basal area	No. trees	Basal area	No. trees	Basal area	No. trees	Basal area
1	1961	77.01	73.31	13.78	17.95	0.44	1.11	5.40	5.45	3.37	2.18
	1968	79.77	75.30	10.12	16.48	.44	1.02	7.01	5.49	2.70	1.71
2	1961	76.66	84.54	2.22	3.48	1.50	1.61	13.86	8.55	5.76	1.82
	1968	73.43	84.63	2.11	3.30	2.44	1.83	15.10	8.30	6.92	1.94
3	1961	26.16	24.27	62.26	66.72	2.37	3.33	8.90	5.60	.31	.08
	1968	27.32	24.48	60.38	66.43	2.27	3.50	9.59	5.49	.44	.10
4	1962	61.55	57.87	34.78	40.37	.28	.17	3.11	1.53	.28	.06
	1968	65.80	62.74	29.33	35.29	.42	.18	3.52	1.66	.93	.13
5	1962	7.16	6.46	89.44	91.12	.03	.03	3.37	2.39	—	—
	1967	7.48	6.30	88.43	91.33	.03	.03	4.06	2.34	—	—
6	1961	11.86	8.07	83.01	88.70	.46	.41	4.63	2.81	.04	.01
	1967	12.16	7.91	82.76	89.28	.48	.37	4.56	2.43	.04	.01
7	1949	66.89	69.78	23.66	23.58	2.09	2.43	7.36	4.21	—	—
	1961	63.97	66.31	20.93	25.74	2.75	2.82	12.29	5.12	.06	.01
8	1953	88.43	89.62	6.32	6.78	1.02	.28	4.23	3.32	—	—
	1962	89.54	90.47	5.04	5.76	1.08	.33	4.34	3.44	—	—

[1]Group 1: White oak, chestnut oak.
Group 2: Black oak, scarlet oak, northern red oak.
Group 3: Black walnut, yellow-poplar, ash, basswood, sycamore, black cherry, shortleaf pine, hemlock.
Group 4: Hickory, black gum, red maple, sugar maple, post oak, blackjack oak, red elm, beech, black locust, shingle oak, hackberry.
Group 5: Dogwood, serviceberry, sourwood, ironwood, sassafras, holly, redbud, hawthorn, burr oak, mulberry, miscellaneous shrubs.

age varied little both within and between plots for a given series. Detailed measurements on no fewer than 10 sample trees per plot provided age, site, and height data at the time of plot installation. These sample trees, mostly dominant or codominant, were selected for their high potential as final crop trees and for their spatial distribution.

Similar marking rules were used for each series to create four or more stand-density levels. Cutting varied from very light or none to removing 70 or 80 percent of the original basal area, except for the older study in Iowa, where the heaviest cutting removed only about 30 percent of the basal area. After this initial cutting, plots ranged in basal area from a low of 20 to 30 square feet per acre up to between 75 and 110 square feet.

The thinning method we used resembled a selection thinning as defined by the Society of American Foresters (*1950*). However, our thinning procedure is more accurately described (*Braathe 1957*) as "free thinning," in which the marker is free to remove trees through all crown classes. Our objective was to leave a suitable number of the best stems as evenly spaced as possible over the plot. In general, we cut the larger cull and defective trees first, then competing trees of poor form and quality, then intermediate and suppressed trees of lower quality and value, and finally, if necessary, the lower value species of the main crown class. High-quality desirable species were cut also if necessary to achieve a uniform spatial distribution.

The number of years of growth data varied among different series of plots from 5 years to 12 years (table 1). Plot size also varied by series from ⅕ to 1 acre in size. In our analysis these differences were disregarded, and all plots received equal weight in the regression analyses. The Ohio State University/Econ step-wise regression program was used for all regression equations.

Averages were used for some independent variables such as basal area, age, number of trees, and plot volumes, rather than the

initial or final plot values. These average values are preferable when calculus methods are used. To determine average basal area, as an example, the initial and most recent measurements were used to compute basal area by equation from the individual tree diameters for all trees greater than 2.6 inches d.b.h., summed over all trees on a plot, and expanded to a per-acre basis. Then the initial and most recent basal areas per acre were averaged to provide the average basal area per acre over the growth interval. Net annual growth in basal area and volume, expressed as the average per acre per year, was obtained as the difference between the final and initial per-acre values divided by the number of years in the growth period.

Average cubic and board-foot volumes were computed in the same manner as basal area; however, the tree-volume equations required both total tree height and tree diameter as independent variables. Therefore total tree height was estimated by regression, using sample tree data; and this estimate of height was substituted into the volume equations. Two different tree-height equations were used; one for the white oak group and one for the red oak group. All volume estimates were for gross content, and no allowances were made for defect.

The summarized plot data were used to fit several recently published growth and yield models as well as some model forms we hypothesized. In these models we tried various transformations and combinations of independent variables such as stand age, basal area, number of trees, site quality, and average stand diameter.

The models we selected for basal-area growth and total cubic-foot volume are, respectively:

$$Y_1 = -BA \cdot LnB + 3.68521BA^{.75} + .011383BSA^{1.05} \quad [1]$$

$$Y_2 = 3.09094 + .009302S + 1.03909LnB - 20.11035A^{-1} \quad [2]$$

where:

Y_1 = net annual basal area growth per acre in square feet for all trees 2.6 inches or larger in d.b.h.

Y_2 = natural logarithm of total cubic-foot volume per acre for all trees 2.6 inches or larger in d.b.h.

B = basal area in square feet per acre of all living trees 2.6 inches or larger in d.b.h.

S = site index in feet

A = average stand age in years.

These equations provide a statistically close fit of the data; they are simpler in form than some proposed; and the growth trends in relation to age, site, and basal area agree well with biological assumptions. Plotting residuals (actual minus predicted values) over age, site, and basal area produced no evidence of nonconformity of these models over most of the range of all variables. Statistical information for these equations is given in table 11 (appendix).

Merchantable cubic-foot and board-foot volume estimates were obtained by multiplying the total cubic-foot volume by the ratio of merchantable cubic-foot or board-foot volume to total cubic-foot volume. Cordwood volume was estimated by dividing the merchantable cubic-foot volume by 80. Both the merchantable cubic-foot and board-foot ratios increase with the average stand diameter. These relationships, described by equations 4 and 5 (table 11, appendix), were developed by regressing the volume ratio data on average stand diameter for the 154 study plots. The calculated volume ratios using equations 4 and 5 are shown in table 12 (appendix), by 1-inch d.b.h. classes. The volume ratios change most rapidly when stand diameter is near the threshold diameter (4.6 inches for cordwood and 8.6 inches for board-foot volume). Both volume ratios gradually approach constant values as stand diameter increases.

It is not feasible to give volume estimates here for all combinations of age, site, and basal area over a range of different average stand diameters. So, in the tables presented here, we used a regression equation to determine average stand diameter as a function of site and age (equation 3, table 11, appendix). Then this average stand diameter was adjusted for each site and age class to reflect changes in average stand diameter due to intensity of cutting. These adjusted average stand diameters are given in table 13 (appendix), by site, age, and residual basal area after the initial thinning. They were

substituted into equations 4 and 5 to compute the volume ratios, hence these assumed average stand diameters affect the cordwood and board-foot volume estimates presented here. When stand diameters are different than those shown in table 13 the estimates of cordwood and board-foot volume will be different.

A Fortran IV computer program is available, upon request, that will provide these growth and yield estimates up to 30 years after initial thinning for any desired combination of age, site, basal area, and average stand diameter. The only program input variables required are initial stand age, basal area, number of trees above 2.6 inches d.b.h., and site index. This program includes ingrowth and mortality functions that are used to adjust the number of trees annually.

RESULTS

Growth and yield predictions are given for thinned upland oak stands in tables 3 through 10. Estimates are given by age, basal area, and site class, all in increments of 10 units; from age 20 to 110 years, from 20 to 130 square feet of basal area; and from site index 55 to 85. All values were generated by the Fortran IV computer program, which incorporated the equations listed in table 11 (appendix), along with ingrowth and mortality functions.

Table 3 gives the current annual net basal-area growth per acre for specified ages and residual basal areas for each site class. These growth estimates are the solutions one would get by substituting into equation 1 the specified ages, sites, and basal areas. For example, a stand on site 65 with a residual basal area of 50 square feet at age 30 will on the average grow 2.54 square feet between age 30 and 31. A year later, age and basal area will have changed, and so will our estimate of growth.

The 10-year estimates of net basal-area growth in table 4 were obtained by repeatedly solving equation 1, each time updating age and basal area, and summing the 10 annual growth estimates. The stand from the previous example with 50 square feet of basal area at age 30 on site 65 would increase in basal area by 21.46 square feet over 10 years, or at age 40 this stand would reach 71.46 square feet of basal area.

Estimates of total cubic-foot volume, including bark, stump, and tip of all trees 2.6 inches d.b.h. or larger, are given in table 5. These volume estimates were obtained by solving equation 2 for each combination of age, site, and basal area. Total cubic-foot volume growth for 10 years (table 6) was obtained as the difference between the initial volume estimate (using the initial age and basal area) and the volume 10 years later, (using an updated age and basal area).

For the previous stand conditions, the total cubic-foot volume at age 30 would be 1,200 cubic feet (table 5). In 10 years, at age 40, the stand would reach 71.46 square feet of basal area; so equation 2 for these stand conditions would predict a stand total volume of 2,057 cubic feet. The difference between the final and initial volumes (2,057 minus 1,200) is the net volume growth for 10 years, or 857 cubic feet as shown in table 6.

The cordwood volume shown in table 7 is the merchantable volume in cubic feet divided by 80. Merchantable cubic-foot volume pertains to the gross content of all trees 4.6 inches d.b.h. or larger, excluding the bark, stump, and branches to a 4-inch top d.i.b. Merchantable cubic-foot volume is not shown, but was calculated by multiplying the total cubic-foot volume by the ratio of merchantable to total volume. This ratio is related to average stand diameter (equation 4, table 11, appendix) and was computed for each average stand diameter given in table 13 (appendix).

An illustration using the previous stand conditions should clarify the procedure. The average stand diameter for age 30 on site 65 with 50 square feet of basal area is 5.2 inches d.b.h. (table 13, appendix). Using 5.2 inches as the average stand diameter and applying equation 4 (appendix), we predict a merchantable to total volume ratio of 0.540. Multiplying this ratio by the total cubic-foot volume (0.540 x 1,200) gives 648 merchantable cubic feet, and dividing by 80 gives 8.1 cords, as shown in table 7. Growth in cords over the next 10-year period is given in table 8 by initial age and initial basal area. Net growth in cords is the difference between the volume 10 years hence and the initial volume in cords.

The merchantable to total cubic-foot ratio

Continued on page 14

Table 3.—*Current annual basal-area increment per acre for given age and basal area*

[In square feet]

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	2.88	2.16	1.76	1.51	1.32	1.19	1.08	1.00	0.93	0.87
30	3.21	2.44	2.01	1.73	1.53	1.38	1.26	1.16	1.08	1.02
40	3.23	2.49	2.07	1.80	1.60	1.45	1.33	1.23	1.15	1.09
50	3.03	2.38	2.01	1.76	1.58	1.44	1.33	1.24	1.16	1.10
60	2.63	2.14	1.84	1.63	1.48	1.36	1.27	1.19	1.12	1.06
70	2.09	1.78	1.58	1.43	1.32	1.23	1.15	1.09	1.04	.99
80	—	1.34	1.25	1.17	1.10	1.05	1.00	.95	.92	.88
90	—	—	.85	.85	.84	.82	.80	.78	.76	.74
100	—	—	—	—	.54	.56	.58	.58	.58	.58
110	—	—	—	—	—	—	.32	.35	.38	.40
120	—	—	—	—	—	—	—	—	—	.19
					SITE INDEX 65					
20	2.98	2.22	1.81	1.54	1.36	1.21	1.10	1.02	0.94	0.88
30	3.36	2.53	2.08	1.78	1.57	1.42	1.29	1.19	1.11	1.04
40	3.43	2.62	2.17	1.87	1.66	1.50	1.38	1.27	1.19	1.12
50	3.27	2.54	2.13	1.85	1.66	1.51	1.39	1.29	1.21	1.14
60	2.93	2.33	1.98	1.75	1.57	1.44	1.34	1.25	1.17	1.11
70	2.43	2.01	1.75	1.56	1.43	1.32	1.23	1.16	1.10	1.05
80	—	1.59	1.44	1.32	1.23	1.15	1.09	1.03	.99	.95
90	—	—	1.06	1.02	.98	.94	.91	.87	.84	.82
100	—	—	—	.68	.69	.70	.69	.68	.67	.66
110	—	—	—	—	—	.41	.45	.47	.48	.49
120	—	—	—	—	—	—	—	.22	.26	.29
130	—	—	—	—	—	—	—	—	—	.07
					SITE INDEX 75					
20	3.07	2.29	1.86	1.58	1.39	1.24	1.13	1.04	0.96	0.90
30	3.50	2.63	2.15	1.84	1.62	1.45	1.33	1.22	1.14	1.06
40	3.62	2.75	2.26	1.95	1.72	1.56	1.42	1.32	1.23	1.15
50	3.52	2.70	2.25	1.95	1.73	1.57	1.44	1.34	1.25	1.18
60	3.22	2.52	2.12	1.86	1.67	1.52	1.40	1.31	1.23	1.16
70	2.78	2.23	1.91	1.70	1.54	1.41	1.31	1.23	1.16	1.10
80	2.20	1.85	1.63	1.47	1.35	1.26	1.18	1.12	1.06	1.01
90	—	1.38	1.28	1.19	1.12	1.06	1.01	.97	.93	.89
100	—	—	.87	.86	.85	.83	.81	.78	.76	.74
110	—	—	—	—	.53	.56	.57	.58	.58	.58
120	—	—	—	—	—	—	.31	.34	.37	.38
130	—	—	—	—	—	—	—	—	.14	.17
					SITE INDEX 85					
20	3.17	2.35	1.90	1.62	1.42	1.27	1.15	1.06	0.98	0.91
30	3.65	2.73	2.22	1.89	1.67	1.49	1.36	1.25	1.16	1.09
40	3.82	2.88	2.36	2.02	1.79	1.61	1.47	1.36	1.26	1.18
50	3.76	2.86	2.36	2.04	1.81	1.64	1.50	1.39	1.30	1.22
60	3.52	2.71	2.26	1.97	1.76	1.60	1.47	1.37	1.28	1.21
70	3.12	2.46	2.08	1.83	1.64	1.50	1.39	1.30	1.23	1.16
80	2.59	2.10	1.82	1.62	1.48	1.36	1.27	1.20	1.13	1.08
90	—	1.67	1.49	1.36	1.26	1.18	1.11	1.06	1.01	.96
100	—	—	1.10	1.05	1.00	.96	.92	.89	.85	.83
110	—	—	—	.70	.71	.70	.70	.69	.68	.67
120	—	—	—	—	—	.42	.45	.46	.48	.48
130	—	—	—	—	—	—	—	.22	.25	.28

Table 4.—*Net basal-area growth in 10 years, by initial age and basal area*

[In square feet per acre]

Initial basal area	Initial stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	27.76	21.82	18.16	15.67	13.85	12.46	11.35	10.46	9.71	9.08
30	27.84	22.61	19.23	16.85	15.08	13.70	12.59	11.68	10.91	10.26
40	26.12	21.81	18.91	16.81	15.21	13.94	12.91	12.05	11.32	10.69
50	23.27	19.99	17.67	15.93	14.58	13.48	12.58	11.82	11.16	10.59
60	19.62	17.42	15.75	14.44	13.38	12.50	11.76	11.13	10.58	10.10
70	15.37	14.29	13.31	12.46	11.74	11.11	10.57	10.09	9.66	9.28
80	—	10.70	10.44	10.09	9.73	9.38	9.05	8.74	8.46	8.20
90	—	—	7.21	7.39	7.41	7.35	7.26	7.14	7.02	6.89
100	—	—	—	—	4.83	5.08	5.24	5.32	5.36	5.37
110	—	—	—	—	—	—	3.01	3.31	3.53	3.69
120	—	—	—	—	—	—	—	—	—	1.85
					SITE INDEX 65					
20	29.06	22.68	18.79	16.16	14.25	12.79	11.64	10.71	9.93	9.28
30	29.43	23.70	20.05	17.50	15.62	14.16	12.99	12.03	11.22	10.54
40	27.96	23.11	19.90	17.60	15.87	14.50	13.40	12.48	11.71	11.04
50	25.33	21.46	18.81	16.86	15.35	14.15	13.16	12.34	11.63	11.02
60	21.87	19.07	17.04	15.49	14.27	13.27	12.44	11.73	11.12	10.59
70	17.79	16.08	14.73	13.63	12.73	11.97	11.32	10.76	10.27	9.84
80	—	12.64	11.99	11.37	10.82	10.33	9.89	9.49	9.14	8.82
90	—	—	8.88	8.78	8.60	8.39	8.18	7.97	7.76	7.57
100	—	—	—	5.90	6.11	6.21	6.24	6.22	6.18	6.12
110	—	—	—	—	—	3.81	4.09	4.28	4.41	4.50
120	—	—	—	—	—	—	—	2.16	2.47	2.71
130	—	—	—	—	—	—	—	—	—	.79
					SITE INDEX 75					
20	30.38	23.55	19.43	16.65	14.65	13.13	11.93	10.96	10.16	9.48
30	31.06	24.81	20.88	18.16	16.16	14.62	13.38	12.38	11.53	10.82
40	29.85	24.42	20.90	18.41	16.54	15.08	13.90	12.92	12.10	11.40
50	27.43	22.97	19.97	17.80	16.14	14.83	13.75	12.86	12.10	11.44
60	24.18	20.74	18.34	16.56	15.17	14.04	13.12	12.34	11.67	11.09
70	20.28	17.92	16.17	14.82	13.73	12.84	12.09	11.45	10.89	10.40
80	15.89	14.62	13.56	12.67	11.93	11.29	10.74	10.25	9.83	9.45
90	—	10.93	10.58	10.19	9.80	9.44	9.11	8.80	8.52	8.26
100	—	—	7.30	7.42	7.41	7.35	7.24	7.13	7.00	6.87
110	—	—	—	—	4.79	5.03	5.17	5.25	5.29	5.31
120	—	—	—	—	—	—	2.91	3.21	3.42	3.59
130	—	—	—	—	—	—	—	—	1.40	1.72
					SITE INDEX 85					
20	31.74	24.44	20.07	17.15	15.06	13.47	12.22	11.22	10.38	9.68
30	32.74	25.94	21.72	18.83	16.71	15.08	13.78	12.73	11.85	11.10
40	31.78	25.77	21.92	19.22	17.21	15.65	14.40	13.36	12.49	11.75
50	29.60	24.50	21.15	18.75	16.94	15.51	14.35	13.39	12.57	11.87
60	26.55	22.45	19.67	17.64	16.07	14.83	13.80	12.95	12.22	11.58
70	22.84	19.79	17.63	16.02	14.75	13.72	12.86	12.14	11.51	10.97
80	18.62	16.64	15.16	13.99	13.04	12.26	11.59	11.02	10.52	10.08
90	—	13.10	12.31	11.62	11.02	10.50	10.05	9.64	9.28	8.95
100	—	—	9.14	8.95	8.73	8.49	8.26	8.04	7.83	7.63
110	—	—	—	6.03	6.19	6.26	6.27	6.24	6.19	6.13
120	—	—	—	—	—	3.83	4.08	4.26	4.38	4.46
130	—	—	—	—	—	—	—	2.12	2.42	2.66

Table 5.—*Total cubic-foot volume of all trees over 2.5 inches d.b.h., by age and basal area*

[In cubic feet]

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	302	422	499	552	590	619	642	660	675	687
30	460	643	760	841	899	943	978	1,005	1,028	1,047
40	620	867	1,025	1,134	1,213	1,272	1,318	1,356	1,386	1,412
50	782	1,093	1,293	1,430	1,529	1,604	1,663	1,710	1,748	1,781
60	945	1,322	1,563	1,728	1,848	1,938	2,009	2,066	2,113	2,152
70	1,109	1,551	1,834	2,028	2,169	2,275	2,358	2,425	2,480	2,526
80	—	1,782	2,107	2,330	2,492	2,614	2,709	2,786	2,849	2,902
90	—	—	2,381	2,633	2,816	2,954	3,062	3,149	3,220	3,279
100	—	—	—	—	3,142	3,296	3,416	3,513	3,593	3,659
110	—	—	—	—	—	—	3,772	3,879	3,967	4,040
120	—	—	—	—	—	—	—	—	—	4,422
					SITE INDEX 65					
20	331	463	548	606	648	679	704	724	740	754
30	505	706	835	923	987	1,035	1,073	1,104	1,128	1,149
40	681	952	1,125	1,244	1,331	1,396	1,447	1,488	1,522	1,550
50	858	1,200	1,419	1,569	1,678	1,760	1,825	1,876	1,919	1,954
60	1,037	1,450	1,715	1,896	2,028	2,127	2,205	2,268	2,319	2,362
70	1,218	1,702	2,013	2,226	2,380	2,497	2,588	2,662	2,722	2,772
80	—	1,956	2,313	2,557	2,734	2,869	2,973	3,058	3,127	3,185
90	—	—	2,614	2,890	3,091	3,242	3,361	3,456	3,534	3,599
100	—	—	—	3,225	3,448	3,617	3,749	3,856	3,943	4,016
110	—	—	—	—	—	3,994	4,140	4,257	4,353	4,434
120	—	—	—	—	—	—	—	4,660	4,765	4,853
130	—	—	—	—	—	—	—	—	—	5,274
					SITE INDEX 75					
20	364	508	601	665	711	746	773	795	813	828
30	554	775	916	1,013	1,083	1,136	1,178	1,211	1,238	1,261
40	747	1,045	1,235	1,366	1,460	1,532	1,588	1,633	1,670	1,701
50	942	1,317	1,557	1,722	1,842	1,932	2,002	2,059	2,106	2,145
60	1,138	1,592	1,882	2,081	2,226	2,335	2,420	2,489	2,545	2,592
70	1,336	1,868	2,209	2,443	2,612	2,740	2,841	2,921	2,987	3,042
80	1,535	2,146	2,538	2,806	3,001	3,148	3,263	3,356	3,432	3,495
90	—	2,426	2,868	3,172	3,392	3,558	3,688	3,793	3,878	3,950
100	—	—	3,200	3,539	3,784	3,970	4,115	4,231	4,327	4,407
110	—	—	—	—	4,178	4,383	4,543	4,672	4,778	4,866
120	—	—	—	—	—	—	4,973	5,114	5,230	5,326
130	—	—	—	—	—	—	—	—	5,683	5,788
					SITE INDEX 85					
20	399	558	660	729	780	818	848	872	892	908
30	608	850	1,005	1,112	1,189	1,247	1,293	1,329	1,359	1,384
40	820	1,146	1,355	1,499	1,603	1,681	1,743	1,792	1,833	1,867
50	1,034	1,445	1,709	1,890	2,021	2,120	2,198	2,260	2,311	2,354
60	1,249	1,747	2,066	2,284	2,443	2,562	2,656	2,731	2,793	2,845
70	1,467	2,050	2,425	2,681	2,867	3,008	3,117	3,206	3,278	3,339
80	1,685	2,356	2,785	3,080	3,294	3,455	3,581	3,683	3,766	3,836
90	—	2,662	3,148	3,481	3,722	3,905	4,048	4,162	4,256	4,335
100	—	—	3,512	3,884	4,153	4,357	4,516	4,644	4,749	4,837
110	—	—	—	4,288	4,585	4,810	4,986	5,127	5,243	5,340
120	—	—	—	—	—	5,266	5,458	5,613	5,739	5,845
130	—	—	—	—	—	—	—	6,099	6,237	6,352

Table 6.—*Net cubic-volume growth per acre in 10 years, by initial age and basal area*

[In cubic feet per acre]

Initial basal area	Initial stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	741	652	581	525	479	442	411	385	362	342
30	812	720	646	588	541	502	469	441	417	396
40	842	745	670	612	565	527	495	467	443	422
50	844	740	665	608	563	527	496	470	447	427
60	828	715	639	584	542	508	479	455	435	416
70	797	673	596	543	504	473	448	427	409	393
80	—	619	540	489	453	426	405	387	372	359
90	—	—	472	423	391	368	351	337	325	315
100	—	—	—	—	320	301	288	278	270	264
110	—	—	—	—	—	—	217	212	208	205
120	—	—	—	—	—	—	—	—	—	140
					SITE INDEX 65					
20	845	741	658	593	540	498	462	432	406	384
30	931	822	736	668	613	568	530	498	470	446
40	970	856	768	699	645	600	562	530	502	477
50	979	857	768	700	647	604	567	536	510	486
60	966	834	744	678	627	587	553	524	499	477
70	937	793	701	638	590	553	522	496	474	455
80	—	738	644	582	538	505	478	456	437	420
90	—	—	573	514	474	445	422	404	388	375
100	—	—	—	435	399	374	356	342	331	321
110	—	—	—	—	—	295	282	272	265	259
120	—	—	—	—	—	—	—	194	192	190
130	—	—	—	—	—	—	—	—	—	115
					SITE INDEX 75					
20	964	841	744	669	609	560	519	485	456	430
30	1,067	939	838	758	695	643	599	562	530	502
40	1,117	982	879	799	735	682	638	601	568	540
50	1,133	990	884	805	742	691	648	612	580	553
60	1,124	971	864	786	725	677	636	602	573	547
70	1,098	931	822	746	689	643	606	575	548	525
80	1,056	875	764	690	636	595	562	534	510	490
90	—	806	692	620	570	533	504	481	461	444
100	—	—	607	537	492	460	436	416	401	388
110	—	—	—	—	403	376	357	343	332	323
120	—	—	—	—	—	—	270	261	254	250
130	—	—	—	—	—	—	—	—	170	170
					SITE INDEX 85					
20	1,099	954	842	755	686	630	583	544	511	482
30	1,222	1,070	952	860	787	726	676	634	597	565
40	1,285	1,126	1,005	911	836	775	724	680	643	610
50	1,310	1,141	1,018	924	850	790	740	697	660	628
60	1,307	1,127	1,001	908	837	779	731	690	656	625
70	1,283	1,090	961	870	802	747	702	665	633	605
80	1,243	1,034	903	814	749	698	658	624	595	570
90	—	963	829	742	681	635	599	569	544	522
100	—	—	741	656	599	558	527	502	482	464
110	—	—	—	559	507	471	445	425	409	396
120	—	—	—	—	—	373	353	339	328	319
130	—	—	—	—	—	—	—	244	238	235

Table 7.—*Total cordwood volume per acre of all trees over 4.5 inches d.b.h., by age and basal area*

[In cords per acre]

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	0.8	2.6	4.0	4.9	5.4	5.7	5.9	6.1	6.2	6.3
30	1.3	3.9	6.1	7.4	8.2	8.7	9.0	9.2	9.4	9.6
40	1.5	5.0	8.1	9.9	11.0	11.7	12.1	12.5	12.7	13.0
50	1.7	5.9	9.9	12.4	13.8	14.7	15.3	15.7	16.1	16.4
60	1.8	6.7	11.6	14.8	16.6	17.7	18.4	19.0	19.4	19.8
70	1.8	7.3	13.0	17.0	19.4	20.7	21.6	22.3	22.8	23.2
80	—	7.7	14.4	19.2	22.1	23.8	24.8	25.6	26.2	26.7
90	—	—	15.6	21.3	24.7	26.8	28.0	28.9	29.6	30.1
100	—	—	—	—	27.4	29.8	31.2	32.2	33.0	33.6
110	—	—	—	—	—	—	34.4	35.6	36.4	37.1
120	—	—	—	—	—	—	—	—	—	40.6
					SITE INDEX 65					
20	1.4	3.4	4.8	5.5	5.9	6.2	6.5	6.7	6.8	6.9
30	2.0	5.1	7.2	8.4	9.1	9.5	9.9	10.1	10.4	10.6
40	2.5	6.7	9.7	11.3	12.2	12.8	13.3	13.7	14.0	14.2
50	2.9	8.1	12.0	14.2	15.4	16.2	16.8	17.2	17.6	18.0
60	3.2	9.4	14.3	17.0	18.5	19.5	20.3	20.8	21.3	21.7
70	3.3	10.5	16.4	19.8	21.7	22.9	23.8	24.5	25.0	25.5
80	—	11.4	18.4	22.6	24.9	26.3	27.3	28.1	28.7	29.3
90	—	—	20.3	25.3	28.0	29.7	30.9	31.7	32.5	33.1
100	—	—	—	27.9	31.2	33.1	34.4	35.4	36.2	36.9
110	—	—	—	—	—	36.5	38.0	39.1	40.0	40.7
120	—	—	—	—	—	—	—	42.8	43.8	44.6
130	—	—	—	—	—	—	—	—	—	48.4
					SITE INDEX 75					
20	1.9	4.1	5.4	6.1	6.5	6.8	7.1	7.3	7.5	7.6
30	2.9	6.3	8.2	9.3	9.9	10.4	10.8	11.1	11.4	11.6
40	3.7	8.3	11.1	12.5	13.4	14.1	14.6	15.0	15.3	15.6
50	4.3	10.2	13.8	15.7	16.9	17.7	18.4	18.9	19.3	19.7
60	4.8	12.0	16.6	19.0	20.4	21.4	22.2	22.9	23.4	23.8
70	5.2	13.6	19.2	22.2	24.0	25.2	26.1	26.8	27.4	27.9
80	5.4	15.0	21.8	25.4	27.5	28.9	30.0	30.8	31.5	32.1
90	—	16.3	24.3	28.6	31.1	32.7	33.9	34.8	35.6	36.3
100	—	—	26.8	31.8	34.6	36.5	37.8	38.9	39.8	40.5
110	—	—	—	—	38.2	40.2	41.7	42.9	43.9	44.7
120	—	—	—	—	—	—	45.7	47.0	48.0	48.9
130	—	—	—	—	—	—	—	—	52.2	53.2
					SITE INDEX 85					
20	2.5	4.8	6.0	6.7	7.2	7.5	7.8	8.0	8.2	8.3
30	3.8	7.3	9.2	10.2	10.9	11.5	11.9	12.2	12.5	12.7
40	4.9	9.8	12.3	13.8	14.7	15.4	16.0	16.5	16.8	17.1
50	5.9	12.1	15.5	17.3	18.6	19.5	20.2	20.8	21.2	21.6
60	6.7	14.4	18.7	21.0	22.4	23.5	24.4	25.1	25.7	26.1
70	7.3	16.5	21.8	24.6	26.3	27.6	28.6	29.5	30.1	30.7
80	7.8	18.5	24.9	28.2	30.2	31.7	32.9	33.8	34.6	35.2
90	—	20.3	27.9	31.8	34.2	35.9	37.2	38.2	39.1	39.8
100	—	—	30.9	35.4	38.1	40.0	41.5	42.7	43.6	44.4
110	—	—	—	39.1	42.1	44.2	45.8	47.1	48.2	49.1
120	—	—	—	—	—	48.4	50.1	51.6	52.7	53.7
130	—	—	—	—	—	—	—	56.0	57.3	58.4

Table 8.—*Net cordwood growth per acre in 10 years, by initial age and basal area*

[In cords per acre]

Initial basal area	Initial stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	5.9	6.4	5.7	5.0	4.4	4.1	3.8	3.5	3.3	3.1
30	5.4	7.1	6.4	5.6	5.0	4.6	4.3	4.1	3.8	3.6
40	4.3	7.2	6.8	5.9	5.3	4.9	4.5	4.3	4.1	3.9
50	2.9	6.9	6.9	6.0	5.3	4.9	4.6	4.3	4.1	3.9
60	1.5	6.4	6.8	5.9	5.2	4.7	4.4	4.2	4.0	3.8
70	.2	5.6	6.5	5.7	4.9	4.4	4.1	3.9	3.8	3.6
80	—	4.7	6.2	5.4	4.6	4.1	3.8	3.6	3.4	3.3
90	—	—	5.7	5.0	4.2	3.6	3.3	3.1	3.0	2.9
100	—	—	—	—	3.7	3.0	2.7	2.6	2.5	2.4
110	—	—	—	—	—	—	2.1	2.0	1.9	1.9
120	—	—	—	—	—	—	—	—	—	1.3
					SITE INDEX 65					
20	8.0	7.4	6.3	5.5	5.0	4.6	4.2	4.0	3.7	3.5
30	8.2	8.3	7.1	6.2	5.6	5.2	4.9	4.6	4.3	4.1
40	7.6	8.8	7.5	6.6	5.9	5.5	5.2	4.9	4.6	4.4
50	6.6	9.0	7.7	6.6	6.0	5.6	5.2	4.9	4.7	4.5
60	5.2	8.8	7.7	6.5	5.8	5.4	5.1	4.8	4.6	4.4
70	3.7	8.5	7.6	6.3	5.5	5.1	4.8	4.6	4.4	4.2
80	—	8.0	7.4	6.0	5.1	4.7	4.4	4.2	4.0	3.9
90	—	—	7.0	5.5	4.6	4.1	3.9	3.7	3.6	3.4
100	—	—	—	5.0	4.0	3.5	3.3	3.1	3.0	3.0
110	—	—	—	—	—	2.8	2.6	2.5	2.4	2.4
120	—	—	—	—	—	—	—	1.8	1.8	1.7
130	—	—	—	—	—	—	—	—	—	1.1
					SITE INDEX 75					
20	9.6	8.2	6.9	6.2	5.6	5.1	4.8	4.5	4.2	4.0
30	10.5	9.3	7.9	7.0	6.4	5.9	5.5	5.2	4.9	4.6
40	10.6	9.9	8.3	7.4	6.8	6.3	5.9	5.5	5.2	5.0
50	10.2	10.3	8.5	7.5	6.8	6.3	6.0	5.6	5.3	5.1
60	9.3	10.4	8.5	7.3	6.7	6.2	5.8	5.5	5.3	5.0
70	8.1	10.3	8.3	7.0	6.4	5.9	5.6	5.3	5.0	4.8
80	6.7	10.0	8.0	6.6	5.9	5.5	5.2	4.9	4.7	4.5
90	—	9.6	7.6	6.1	5.3	4.9	4.6	4.4	4.2	4.1
100	—	—	7.0	5.4	4.6	4.2	4.0	3.8	3.7	3.6
110	—	—	—	—	3.8	3.5	3.3	3.1	3.0	3.0
120	—	—	—	—	—	—	2.5	2.4	2.3	2.3
130	—	—	—	—	—	—	—	—	1.6	1.6
					SITE INDEX 85					
20	11.0	9.1	7.8	6.9	6.3	5.8	5.4	5.0	4.7	4.4
30	12.3	10.3	8.8	7.9	7.2	6.7	6.2	5.8	5.5	5.2
40	12.9	11.0	9.3	8.4	7.7	7.1	6.7	6.3	5.9	5.6
50	13.1	11.4	9.5	8.5	7.8	7.3	6.8	6.4	6.1	5.8
60	12.8	11.5	9.5	8.4	7.7	7.2	6.7	6.3	6.0	5.7
70	12.2	11.5	9.2	8.1	7.4	6.9	6.5	6.1	5.8	5.6
80	11.3	11.2	8.9	7.6	6.9	6.4	6.0	5.7	5.5	5.2
90	—	10.9	8.4	7.0	6.3	5.8	5.5	5.2	5.0	4.8
100	—	—	7.7	6.2	5.5	5.1	4.8	4.6	4.4	4.3
110	—	—	—	5.4	4.7	4.3	4.1	3.9	3.8	3.6
120	—	—	—	—	—	3.4	3.2	3.1	3.0	2.9
130	—	—	—	—	—	—	—	2.2	2.2	2.2

Table 9.—*Total board-foot volume per acre of all trees over 8.5 inches d.b.h., by age and basal area*

[In board feet per acre]

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	0	0	118	411	898	1,431	1,870	2,178	2,359	2,434
30	0	0	168	619	1,335	2,134	2,850	3,320	3,587	3,709
40	0	0	186	727	1,651	2,708	3,696	4,401	4,789	4,988
50	0	0	175	770	1,834	3,156	4,397	5,361	5,968	6,263
60	0	0	156	777	1,936	3,490	4,997	6,267	7,049	7,507
70	0	0	119	743	1,954	3,646	5,451	6,966	8,071	8,718
80	—	0	83	690	1,929	3,728	5,767	7,601	8,989	9,858
90	—	—	43	630	1,858	3,749	6,008	8,125	9,791	10,940
100	—	—	—	—	1,824	3,808	6,225	8,595	10,574	12,001
110	—	—	—	—	—	—	6,462	9,123	11,348	13,007
120	—	—	—	—	—	—	—	—	—	14,045
					SITE INDEX 65					
20	0	42	325	888	1,545	2,076	2,420	2,558	2,628	2,677
30	0	61	465	1,304	2,330	3,164	3,646	3,893	4,005	4,080
40	0	59	553	1,602	2,929	4,119	4,851	5,234	5,400	5,501
50	0	43	572	1,772	3,394	4,922	5,985	6,552	6,801	6,937
60	0	22	568	1,866	3,783	5,669	7,027	7,820	8,200	8,383
70	0	0	523	1,859	3,976	6,201	7,960	9,042	9,587	9,836
80	0	0	475	1,836	4,084	6,630	8,774	10,175	10,934	11,289
90	—	—	419	1,768	4,122	6,914	9,463	11,241	12,238	12,727
100	—	—	—	1,736	4,167	7,267	10,144	12,238	13,521	14,163
110	—	—	—	—	—	7,538	10,764	13,218	14,789	15,580
120	—	—	—	—	—	—	—	14,293	16,048	17,007
130	—	—	—	—	—	—	—	—	—	18,451
					SITE INDEX 75					
20	0	135	654	1,439	2,172	2,562	2,737	2,821	2,885	2,938
30	0	195	960	2,192	3,260	3,891	4,171	4,299	4,396	4,478
40	0	219	1,155	2,716	4,256	5,171	5,610	5,797	5,928	6,038
50	0	215	1,262	3,160	5,093	6,378	7,028	7,308	7,475	7,613
60	0	195	1,318	3,447	5,818	7,534	8,421	8,825	9,034	9,201
70	0	156	1,277	3,563	6,318	8,532	9,776	10,332	10,603	10,800
80	0	117	1,224	3,648	6,770	9,402	11,052	11,831	12,179	12,407
90	—	76	1,161	3,643	7,073	10,137	12,221	13,291	13,756	14,022
100	—	—	1,116	3,680	7,345	10,920	13,358	14,731	15,332	15,644
110	—	—	—	—	7,637	11,640	14,528	16,130	16,900	17,272
120	—	—	—	—	—	—	15,691	17,575	18,483	18,905
130	—	—	—	—	—	—	—	—	20,058	20,544
					SITE INDEX 85					
20	2	296	1,119	2,072	2,650	2,898	3,011	3,096	3,166	3,225
30	0	429	1,645	3,075	4,003	4,409	4,588	4,718	4,825	4,914
40	0	503	2,024	3,975	5,333	5,928	6,187	6,362	6,506	6,626
50	0	524	2,276	4,710	6,537	7,423	7,800	8,023	8,204	8,355
60	0	515	2,423	5,280	7,628	8,916	9,422	9,696	9,915	10,098
70	0	471	2,459	5,693	8,590	10,287	11,035	11,380	11,638	11,852
80	0	423	2,439	5,968	9,418	11,623	12,640	13,073	13,370	13,616
90	—	367	2,397	6,169	10,171	12,847	14,204	14,771	15,110	15,389
100	—	—	2,373	6,354	10,793	14,041	15,746	16,470	16,859	17,170
110	—	—	—	6,566	11,478	15,219	17,273	18,168	18,613	18,957
120	—	—	—	—	—	16,444	18,821	19,873	20,374	20,751
130	—	—	—	—	—	—	—	21,580	22,141	22,551

Table 10.—*Net board-foot growth per acre in 10 years, by initial age and basal area*

[In board feet per acre]

Initial basal area	Initial stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	0	388	962	1,458	1,744	1,742	1,596	1,434	1,304	1,218
30	0	306	947	1,596	1,939	1,955	1,819	1,643	1,502	1,408
40	0	201	838	1,558	2,028	2,096	1,938	1,733	1,587	1,493
50	0	102	690	1,442	2,007	2,160	2,014	1,783	1,602	1,499
60	0	21	564	1,305	1,933	2,169	2,046	1,793	1,578	1,453
70	0	0	441	1,151	1,822	2,130	2,049	1,780	1,523	1,369
80	—	0	347	1,006	1,704	2,075	2,036	1,754	1,452	1,256
90	—	—	270	881	1,581	2,012	2,017	1,726	1,378	1,127
100	—	—	—	—	1,487	1,962	1,998	1,698	1,300	990
110	—	—	—	—	—	—	1,981	1,664	1,218	849
120	—	—	—	—	—	—	—	—	—	701
					SITE INDEX 65					
20	234	1,086	2,023	2,431	2,320	2,008	1,713	1,546	1,442	1,362
30	90	1,000	2,150	2,796	2,730	2,346	2,009	1,791	1,671	1,584
40	0	815	2,095	2,959	3,014	2,612	2,196	1,921	1,783	1,694
50	0	625	1,904	2,969	3,193	2,820	2,329	1,988	1,818	1,726
60	0	473	1,700	2,896	3,299	2,965	2,429	2,018	1,798	1,696
70	0	329	1,462	2,743	3,336	3,092	2,511	2,017	1,738	1,618
80	—	205	1,243	2,528	3,323	3,188	2,585	2,012	1,659	1,503
90	—	—	1,039	2,244	3,157	3,268	2,659	1,997	1,566	1,365
100	—	—	—	1,994	2,948	3,183	2,708	1,979	1,453	1,198
110	—	—	—	—	—	3,051	2,682	1,944	1,322	1,017
120	—	—	—	—	—	—	—	1,840	1,175	810
130	—	—	—	—	—	—	—	—	—	575
					SITE INDEX 75					
20	742	2,227	3,126	3,012	2,480	2,072	1,850	1,722	1,617	1,527
30	483	2,209	3,562	3,598	2,966	2,421	2,136	1,995	1,882	1,783
40	270	1,966	3,673	4,012	3,345	2,671	2,293	2,133	2,017	1,917
50	111	1,653	3,556	4,248	3,674	2,876	2,380	2,175	2,061	1,963
60	1	1,345	3,300	4,305	3,914	3,030	2,421	2,148	2,033	1,941
70	0	1,055	2,915	4,196	4,076	3,193	2,434	2,079	1,947	1,864
80	0	828	2,540	3,998	4,118	3,315	2,452	1,975	1,815	1,740
90	—	645	2,194	3,735	4,093	3,402	2,475	1,869	1,648	1,575
100	—	—	1,900	3,459	3,992	3,380	2,448	1,739	1,451	1,377
110	—	—	—	—	3,832	3,314	2,344	1,600	1,236	1,147
120	—	—	—	—	—	—	2,194	1,389	982	889
130	—	—	—	—	—	—	—	—	711	606
					SITE INDEX 85					
20	1,641	3,542	3,900	3,178	2,554	2,243	2,071	1,932	1,813	1,710
30	1,239	3,704	4,594	3,848	3,008	2,596	2,401	2,249	2,119	2,006
40	876	3,496	4,954	4,356	3,319	2,792	2,570	2,416	2,283	2,167
50	570	3,085	5,020	4,743	3,615	2,906	2,627	2,475	2,344	2,231
60	349	2,626	4,875	5,000	3,872	2,944	2,602	2,451	2,327	2,219
70	173	2,159	4,579	5,127	4,089	3,024	2,526	2,361	2,246	2,147
80	48	1,766	4,202	5,133	4,257	3,058	2,408	2,215	2,112	2,023
90	—	1,429	3,800	5,031	4,343	3,102	2,287	2,025	1,931	1,855
100	—	—	3,418	4,847	4,379	3,089	2,143	1,799	1,710	1,647
110	—	—	—	4,608	4,304	3,016	1,969	1,543	1,454	1,406
120	—	—	—	—	—	2,857	1,738	1,254	1,165	1,133
130	—	—	—	—	—	—	—	936	847	833

changes over the 10-year growth period because average stand diameter increases. The predicted increase in average stand diameter 10 years after the initial thinning is given in table 14 (appendix), by site, age, and the initial residual basal area. Ingrowth and mortality, as well as accretion, affect the change in average stand diameter, and all three elements are incorporated into the program. In our example, average stand diameter would increase from 5.2 to 6.3 inches in 10 years, so the merchantable to total volume ratio would increase from 0.540 to 0.666. Multiplying this ratio by the total cubic-foot volume at age 40 (0.666 x 2,057) gives a merchantable volume of 1,370 cubic feet. Dividing by 80 gives 17.1 cords at age 40, and subtracting the 8.1 cords estimated at age 30 gives the 9.0 cords of growth shown in table 8.

Estimates of board-foot yield (table 9) and board-foot growth for 10 years (table 10) were computed by using the same procedure and the board-foot to total cubic-foot ratios given by equation 5 (appendix).

Many foresters in the central hardwood region are using stocking percent based on Gingrich's (*1964*) tree-area-ratio equation rather than basal area to express stand density. Our computer program calculates both stocking measures, so table 15 (appendix) is included here to aid those interested in expressing growth or yield in relation to stocking percent. The stocking percent shown here by site, age, and residual basal area after the initial thinning will vary when average stand diameter differs from those assumed in table 13 (appendix).

Discussion

The predicted growth and yield values follow expected biological behavior patterns with respect to age, site quality, and stand density. We used these common variables in our equations not only because they are good predictors of growth and yield, but also because they have other utility to silviculturalists and managers and are generally available or else inexpensive and easy to measure.

The equations have received some field testing and it appears that their reliability should be acceptable for most uses. A more complete discussion of sources of error will be included in a Ph.D. manuscript, "Growth and yield functions for thinned upland oak stands," by Martin E. Dale.

The relationships presented here help to establish, in general, the biological capabilities of upland oak stands over a broad range of stand and site conditions. This physical growth-response data are part of the information necessary for objectively evaluating specific thinning practices.

This system of equations indicates that maximum growth in basal area and total cubic-foot volume occurs with a low stocking; usually between 30 and 60 square feet of residual basal area regardless of site or age. Thus the stand density indicated here for maximum growth is somewhat less than that in earlier stocking recommendations *(Dale 1968; Allen and Marquis 1970; and Gingrich 1971);* however, in such recommendations other factors in addition to growth were considered. Initial thinning to such low densities is usually not recommended because this heavy cutting also tends to increase stem taper, reduce height growth, delay natural pruning, and perhaps stimulate epicormic branching of the residual trees.

If heavy thinning does in fact increase stem taper and reduce height growth, then the values presented here may result in overestimating volume at low stocking, and if adjusted, maximum volume growth would occur at a slightly higher stocking. The basal area and volume growth given here also includes ingrowth trees; and this ingrowth component becomes substantial when thinnings remove 50 percent or more of the original density. With such heavy thinnings, the residual crop trees grow rapidly in diameter, but there are not enough crop trees to fully utilize all available space; hence some of the growth potential of the site is diverted to the smaller understory trees or reproduction.

In general, we feel that in upland oak stands it requires at least 50 percent stocking —based on Gingrich's *(1964)* tree-area ratio equation — to fully occupy the area with potential crop trees, and to prevent extensive development of the understory or advanced reproduction. Also, stocking in excess of 50 percent will reduce the probability of adverse effects on stem taper, height growth, branch development, and natural pruning.

Growth in cordwood and board-foot volume is substantially more on the better sites,

although basal-area growth is only slightly affected by site quality. Better sites produce up to 1.3 cords per acre annually between 20 and 30 years while poor sites produce only about ½ cord. Maximum periodic growth rates occur when many trees are reaching ingrowth size; hence the maximum periodic growth rate occurs when mean stand diameter is close to the threshold diameter — 4.6 inches for cordwood and 8.6 inches for sawtimber. Since this threshold diameter is reached at a younger age on the better sites, the peak in periodic mean annual growth is reached sooner on the best sites. This is illustrated in table 8, where cordwood growth on the best sites is shown to be greatest between 20 and 30 years and on poor sites it peaks between 30 and 40 years. Board-foot growth rates (table 10) are greatest at about 50 years on site 85; but on site 55 the peak board-foot growth rate is reached between 70 and 80 years.

Although maximum growth in quantity seems to occur at rather low stocking levels, a variation in basal area of 15 to 20 square feet around this point generally has only a minor effect on the growth rate. For example, on site 65 at age 30, growth is 8 to 9 cords in 10 years with a residual basal area stocking anywhere from 30 to 80 square feet (table 8), and at age 100 we get 4 to 5 cords of growth over the same range of basal-area stocking. Therefore, with such a small loss in quantity of growth and the possibility of adverse effects with low stocking, we feel that in the initial thinning it is better to leave 10 to 20 more square feet of residual basal area than what is indicated for maximum growth rates in the tables.

SUMMARY

Growth and yield equations were developed from the response of 154 permanent growth plots representing a broad range of age, site, and density classes in the upland oak timber type. Originally the stands were fully stocked; but a range of density levels was created by an initial thinning so growth could be studied in relation to stocking. The cubic-foot volume, cordwood, and board-foot volume yields obtained by using these equations are given for a wide range of stand age, site quality, and basal-area classes. Growth was computed for a 10-year period in terms of basal area, cubic-feet, cords, and board feet; and these predictions are given for a broad range of initial age and basal-area classes for site indexes 55, 65, 75, and 85.

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Table 11.—*Regression equations used for growth and yield estimates*

Equation number	Equation form	Mean of dependent variable	Coefficient of determination (R^2)	Root mean square residual ($S_{y \cdot x}$)
(1)	$Y_1 = -BA^{-.5} Ln(B) + 3.68521BA^{-.75} + .011383BSA^{-1.05}$	1.80	0.518	0.733
(2)	$Y_2 = 3.09094 + .00930176S + 1.03909 Ln(B) - 20.11035A^{-1}$	7.463	.984	.064
(3)	$Y_3 = 1.1341 + .0019876AS$	7.9	.867	1.147
(4)	$Y_4 = -.052676 + .7876045 \cdot \exp[-(1.2987 - .08117D)^{10}]$	.632	.985	.016
(5)	$Y_5 = -.088414 + 3.63827 \cdot \exp[-(2.00 - .125D)^4]$	1.277	.969	.235

where

Y_1 = net annual basal area increment per acre including ingrowth for all trees 2.6 inches d.b.h. or larger.

Y_2 = natural logarithm of total cubic foot volume per acre for all trees 2.6 inches d.b.h. or larger, including bark, stump, tip, but no branchwood.

Y_3 = quadratic mean stand diameter of trees 2.6 inches d.b.h. or larger.

Y_4 = ratio of merchantable cubic-foot volume to total cubic-foot volume. Merchantable volume is for all trees 4.6 inches d.b.h. or larger and the volume excludes stump, bark, branches, and tip above 4.5 inch top d.o.b. $Y_4 = 0.0$ if $D<2.3$ and $Y_4 = 0.735$ if $D>16$ inches.

Y_5 = ratio of board-foot volume to total cubic-foot volume. Board-foot volume based on International ¼-inch rule for trees 8.6 inches d.b.h. or larger to a top d.o.b. of 8.5 inches. $Y_5 = 0.0$ if $D<4.8$ inches, and $Y_5 = 3.55$ if $D>16$ inches.

B = basal area in square feet per acre of all living trees 2.6 inches or larger d.b.h.

S = site index in feet at reference age 50.

A = average stand age in years.

D = quadratic mean stand diameter of trees 2.6 inches d.b.h. or larger.

Table 12.—*Ratios of merchantable cubic-foot volume and board-foot volume to total cubic-foot volume, by d.b.h. class*

D.b.h. class (inches)	Merchantable cubic-foot/ total cubic-foot ratio	Board-foot/ total cubic-foot ratio
3	0.0896	0.0
4	.3125	.0
5	.5181	.014
6	.6430	.228
7	.7016	.645
8	.7245	1.250
9	.7322	1.936
10	.7343	2.563
11	.7348	3.035
12	.7349	3.329
13	.7349	3.479
14	.7349	3.536
15	.7349	3.549
16	.7349	3.550
17	.7350	3.550

Table 13.—*Average stand diameter of trees 2.6 inches d.b.h. and larger by site, age, and residual basal area*

[In inches]

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4
30	3.6	4.8	6.0	7.2	8.3	9.5	10.7	11.9	13.1	14.3
40	3.5	4.7	5.8	7.0	8.2	9.3	10.5	11.6	12.8	13.9
50	3.4	4.5	5.7	6.8	7.9	9.0	10.2	11.3	12.4	13.5
60	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2
70	3.2	4.3	5.3	6.4	7.4	8.5	9.6	10.6	11.7	12.7
80	—	4.1	5.2	6.2	7.2	8.3	9.3	10.3	11.3	12.4
90	—	—	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
100	—	—	—	—	6.9	7.9	8.8	9.8	10.8	11.8
110	—	—	—	—	—	—	8.7	9.6	10.6	11.6
120	—	—	—	—	—	—	—	—	—	11.4
					SITE INDEX 65					
20	4.1	5.5	6.9	8.3	9.7	11.1	12.5	13.9	15.3	16.8
30	4.0	5.4	6.8	8.2	9.6	11.0	12.4	13.8	15.2	16.6
40	3.9	5.3	6.7	8.0	9.4	10.8	12.2	13.5	14.9	16.3
50	3.8	5.2	6.5	7.8	9.1	10.5	11.8	13.1	14.5	15.8
60	3.7	5.0	6.3	7.6	8.9	10.2	11.5	12.8	14.1	15.3
70	3.6	4.8	6.1	7.4	8.6	9.9	11.1	12.4	13.6	14.9
80	—	4.7	5.9	7.1	8.4	9.6	10.8	12.0	13.2	14.4
90	—	—	5.8	6.9	8.1	9.3	10.5	11.7	12.8	14.0
100	—	—	—	6.8	7.9	9.1	10.3	11.4	12.6	13.7
110	—	—	—	—	—	8.9	10.1	11.2	12.3	13.5
120	—	—	—	—	—	—	—	11.1	12.2	13.3
130	—	—	—	—	—	—	—	—	—	13.2
					SITE INDEX 75					
20	4.5	6.1	7.7	9.4	11.0	12.6	14.3	15.9	17.5	19.1
30	4.5	6.1	7.7	9.3	10.9	12.5	14.2	15.8	17.4	19.0
40	4.4	5.9	7.5	9.1	10.7	12.3	13.8	15.4	17.0	18.6
50	4.2	5.8	7.3	8.8	10.4	11.9	13.4	15.0	16.5	18.0
60	4.1	5.6	7.1	8.6	10.1	11.6	13.1	14.6	16.0	17.5
70	4.0	5.4	6.9	8.3	9.8	11.2	12.6	14.1	15.5	17.0
80	3.9	5.3	6.7	8.1	9.5	10.9	12.3	13.7	15.1	16.5
90	—	5.1	6.5	7.8	9.2	10.6	11.9	13.3	14.7	16.0
100	—	—	6.3	7.7	9.0	10.3	11.7	13.0	14.3	15.7
110	—	—	—	—	8.8	10.2	11.5	12.8	14.1	15.4
120	—	—	—	—	—	—	11.3	12.6	13.9	15.2
130	—	—	—	—	—	—	—	—	13.8	15.1
					SITE INDEX 85					
20	4.9	6.8	8.6	10.5	12.3	14.2	16.0	17.8	19.7	21.5
30	4.9	6.7	8.6	10.4	12.2	14.0	15.9	17.7	19.5	21.4
40	4.8	6.6	8.4	10.2	11.9	13.7	15.5	17.3	19.1	20.9
50	4.6	6.4	8.1	9.9	11.6	13.3	15.1	16.8	18.6	20.3
60	4.5	6.2	7.9	9.6	11.3	13.0	14.6	16.3	18.0	19.7
70	4.4	6.0	7.6	9.3	10.9	12.5	14.2	15.8	17.5	19.1
80	4.2	5.8	7.4	9.0	10.6	12.2	13.8	15.4	16.9	18.5
90	—	5.7	7.2	8.8	10.3	11.8	13.4	14.9	16.5	18.0
100	—	—	7.1	8.6	10.1	11.6	13.1	14.6	16.1	17.6
110	—	—	—	8.4	9.9	11.4	12.9	14.3	15.8	17.3
120	—	—	—	—	—	11.2	12.7	14.2	15.6	17.1
130	—	—	—	—	—	—	—	14.1	15.5	17.0

Table 14.—*Increase in average stand diameter 10 years after thinning, by site, age, and residual basal area*

[In inches]

Residual basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	1.4	1.6	1.6	1.5	1.4	1.3	1.1	0.9	0.7	0.4
30	.9	1.2	1.3	1.2	1.2	1.0	.9	.7	.5	.2
40	.5	.9	1.1	1.1	1.0	.9	.7	.5	.3	.1
50	.2	.8	.9	.9	1.0	.9	.7	.5	.2	.0
60	.0	.6	.8	.9	.8	.8	.6	.5	.3	.0
70	—	.4	.7	.8	.7	.7	.6	.5	.3	.1
80	—	.3	.6	.7	.8	.7	.6	.5	.3	.0
90	—	—	.6	.7	.7	.7	.6	.5	.3	.1
100	—	—	—	—	.6	.6	.6	.5	.3	.1
110	—	—	—	—	—	—	.6	.5	.3	.1
120	—	—	—	—	—	—	—	—	—	.2
					SITE INDEX 65					
20	1.8	2.0	2.1	2.1	2.0	1.8	1.8	1.5	1.2	0.9
30	1.3	1.7	1.8	1.8	1.7	1.5	1.3	1.2	1.0	.7
40	1.0	1.4	1.5	1.5	1.5	1.4	1.3	1.1	.8	.5
50	.6	1.1	1.3	1.4	1.4	1.4	1.2	.9	.8	.5
60	.4	1.0	1.2	1.3	1.3	1.2	1.2	1.0	.7	.5
70	.2	.8	1.1	1.2	1.2	1.1	1.1	.9	.8	.4
80	—	.7	1.0	1.1	1.1	1.1	1.0	.9	.7	.5
90	—	—	.8	1.0	1.1	1.1	1.0	.9	.8	.5
100	—	—	—	.8	1.0	1.0	1.0	.9	.7	.6
110	—	—	—	—	—	.9	.9	.9	.7	.5
120	—	—	—	—	—	—	—	.9	.8	.6
130	—	—	—	—	—	—	—	—	—	.6
					SITE INDEX 75					
20	2.3	2.6	2.7	2.7	2.6	2.6	2.4	2.1	1.9	1.7
30	1.7	2.1	2.3	2.4	2.4	2.3	2.0	1.8	1.6	1.4
40	1.3	1.8	2.0	2.1	2.1	2.1	1.9	1.7	1.5	1.1
50	1.1	1.5	1.8	1.8	1.9	1.9	1.8	1.6	1.4	1.1
60	.8	1.3	1.5	1.7	1.8	1.8	1.7	1.6	1.3	1.0
70	.6	1.2	1.3	1.5	1.5	1.7	1.6	1.4	1.3	1.0
80	.4	1.0	1.1	1.3	1.4	1.5	1.5	1.5	1.3	1.0
90	—	.9	1.0	1.2	1.3	1.3	1.4	1.4	1.3	1.0
100	—	—	1.0	1.0	1.2	1.2	1.2	1.4	1.2	1.1
110	—	—	—	—	1.1	1.1	1.2	1.2	1.2	1.1
120	—	—	—	—	—	—	1.1	1.2	1.1	1.1
130	—	—	—	—	—	—	—	—	1.1	1.1
					SITE INDEX 85					
20	2.9	3.2	3.4	3.5	3.4	3.3	3.3	2.8	2.9	2.4
30	2.2	2.6	2.8	3.0	3.1	3.0	2.9	2.6	2.5	2.1
40	1.7	2.1	2.4	2.6	2.7	2.8	2.8	2.5	2.3	1.9
50	1.4	1.8	2.1	2.2	2.4	2.5	2.6	2.4	2.2	1.9
60	1.2	1.6	1.8	2.0	2.2	2.2	2.3	2.3	2.1	1.9
70	.9	1.3	1.6	1.7	1.9	2.0	2.0	2.1	2.0	1.8
80	.8	1.2	1.4	1.6	1.7	1.8	1.9	1.9	1.9	1.7
90	—	1.0	1.3	1.4	1.6	1.7	1.7	1.8	1.9	1.7
100	—	—	1.1	1.2	1.4	1.5	1.6	1.7	1.7	1.7
110	—	—	—	1.2	1.3	1.4	1.4	1.6	1.6	1.7
120	—	—	—	—	—	1.3	1.4	1.4	1.5	1.6
130	—	—	—	—	—	—	—	1.3	1.4	1.5

Table 15.—*Stocking percent based on tree-area ratio, by site, age, and residual basal area*

Basal area	Average stand age — years									
	20	30	40	50	60	70	80	90	100	110
					SITE INDEX 55					
20	26	23	21	20	19	18	17	17	16	16
30	39	34	32	30	28	27	26	25	24	24
40	53	46	42	40	38	36	35	33	32	32
50	67	59	54	50	48	45	44	42	41	40
60	81	71	65	61	58	55	53	51	50	48
70	96	84	77	72	68	65	62	60	58	57
80	—	98	89	83	78	75	72	70	67	66
90	—	—	101	94	89	85	82	79	77	74
100	—	—	—	—	100	95	92	88	86	83
110	—	—	—	—	—	—	101	98	95	92
120	—	—	—	—	—	—	—	—	—	101
					SITE INDEX 65					
20	25	22	20	19	18	17	16	16	15	15
30	37	33	30	28	27	26	25	24	23	22
40	50	44	40	38	36	34	33	32	31	30
50	63	56	51	48	45	43	42	40	39	38
60	77	68	62	58	55	52	50	49	47	46
70	91	80	73	68	65	62	59	57	56	54
80	—	92	84	79	75	71	68	66	64	62
90	—	—	96	90	85	81	78	75	73	71
100	—	—	—	100	95	91	87	84	82	79
110	—	—	—	—	—	100	96	93	90	88
120	—	—	—	—	—	—	—	102	99	96
130	—	—	—	—	—	—	—	—	—	104
					SITE INDEX 75					
20	24	21	19	18	17	16	16	15	15	14
30	35	31	29	27	26	24	24	23	22	21
40	48	42	39	36	34	33	32	31	30	29
50	60	53	49	46	43	42	40	39	37	36
60	73	65	59	56	53	50	48	47	45	44
70	87	76	70	66	62	59	57	55	53	52
80	101	88	81	76	72	68	66	63	62	60
90	—	100	92	86	81	78	75	72	70	68
100	—	—	103	96	91	87	84	81	78	76
110	—	—	—	—	101	96	92	89	86	84
120	—	—	—	—	—	—	101	98	95	92
130	—	—	—	—	—	—	—	—	103	100
					SITE INDEX 85					
20	23	20	18	17	16	16	15	15	14	14
30	34	30	28	26	25	24	23	22	21	21
40	46	41	37	35	33	32	30	29	29	28
50	58	51	47	44	42	40	38	37	36	35
60	71	62	57	54	51	48	46	45	44	42
70	84	74	67	63	60	57	55	53	51	50
80	97	85	78	73	69	66	63	61	59	58
90	—	97	88	83	78	75	72	69	67	66
100	—	—	99	93	88	84	80	78	75	73
110	—	—	—	102	97	93	89	86	83	81
120	—	—	—	—	—	101	98	94	91	89
130	—	—	—	—	—	—	—	102	99	96

*U.S. GOVERNMENT PRINTING OFFICE: 1972-707-917/382

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by Frederick H. Berry
and John A. Beaton

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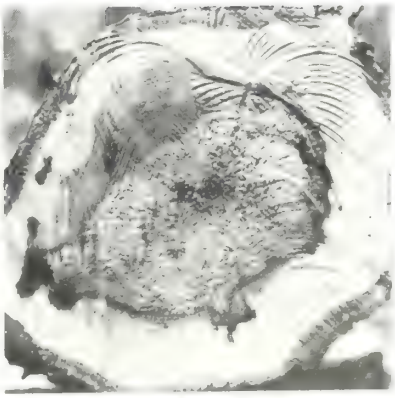
DECAY IN OAK

in the Central Hardwood Region



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NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
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OAK-HICKORY is the predominant forest type in the central hardwood region of Ohio, Indiana, Illinois, and Missouri. This type occupies almost 19 million acres, or about 65 percent of the commercial forest area in these states (fig. 1). These oak-hickory forests are of great economic importance. About 23 billion board feet of sawlog-size oak and 7 billion cubic feet of oak growing stock are found here. And over 500 million board feet of oak sawtimber are harvested annually *(2, 3, 5, 9)*.

Besides giving employment to thousands of workers in the woods and wood-related industries, these forests are heavily utilized by persons from metropolitan areas seeking recreation and relaxation.

Because oak is the leading timber species in the central hardwood region, it is necessary to manage these stands to provide the best possible utilization of this valuable hardwood resource. One of the most critical problems is loss from heartwood decay. More information is needed about this kind of loss.

We undertook a study of the four principal oak species in this region—black oak *(Quercus velutina* Lam.), scarlet oak *(Q. coccinea* Muenchh.), chestnut oak (*Q. prinus* L.), and white oak *(Q. alba* L.)—to determine the quantity of decay, the fungi associated with

Figure 1.—An even-aged upland oak stand in southern Missouri.

decay, and the relation of decay to external indicators, tree age, and diameter. Our aim was to provide forest managers with information to help them keep decay losses in these forests to a minimum.

METHODS

We located sample plots in areas that were representative of oak-hickory forests in the central hardwood region. We selected 113 sample areas in well-stocked, undisturbed (except for fire), even-aged stands 20 to 110 years old. About 75 percent of the areas were on National Forests (Wayne National Forest in Ohio; Hoosier National Forest in Indiana; Shawnee National Forest in Illinois; and Clark and Mark Twain National Forests in Missouri). The remainder were on private land and state forests. Field work, begun in 1962, was completed in 1968.

Sample areas consisted of concentric circular plots 1/20-, 1/10-, and 1/5-acre in size. All living trees 3.6 inches d.b.h. (diameter breast height) and larger were cut on the 1/20-acre plots; trees 5.6 inches d.b.h. and larger were cut on the 1/10-acre plots; and trees 11.6 inches d.b.h. and larger were cut on the 1/5-acre plots. Data collected from trees on the 1/20- and 1/10-acre plots were weighted so that all computations were based on 1/5 acre.

Trees meeting plot specifications were tallied; and d.b.h., age, crown class, and tree condition were recorded. Dead trees were ignored. The tallied trees were then cut at an average stump height of 1 foot. The main stem and merchantable branches were marked into 4-foot lengths up to a 4-inch top diameter (inside bark). Total height was recorded. The kind, extent, and location of all surface indicators of defects were recorded. Each tree was then cut into 4-foot bolts, which were examined for decay. Indicators of defects previously noted were examined; and if decay was associated with them, this was recorded. Where decay was encountered, the bolts were dissected to determine its extent.

The diameter inside bark at 16-foot intervals from stump height to a 4-inch-or-larger merchantable top was recorded. Top and bottom diameters and length of merchantable limbs were recorded. The maximum diameter of decay columns was located, diagrammed, and recorded. Lengths of decay columns were measured in both directions from the maximum diameter and recorded to the nearest 0.5 foot.

From the graphic tree-measurement sheets, we computed volumes in cubic feet, by Smalian's formula ($V = \frac{(B + b)}{2} L$ where B is equal to the basal area in square feet of the large end of the log; b is equal to the basal area of the small end of the log; and L is equal to the length of the log in feet). Gross tree volume was computed at 16-foot intervals from a 1-foot stump to a 4-inch-or-larger merchantable top diameter. No reduction in gross volume was made for trim or breakage. If decay was present, its volume was also computed in cubic feet and subtracted from the gross volume to determine the net tree volume.

Cultures were prepared from decay samples soon after collection to determine the fungi associated with decay. Sample blocks of decayed wood were split to expose a fresh face of infected wood. At least 6 cores of infected wood approximately 4 mm in diameter were removed with a sterilized increment hammer from each block and placed in test tubes containing 2.5-percent Fleischmann's diamalt with 2-percent agar. When the decay fungus was not isolated on the first attempt, re-isolations were attempted.

THE DECAY FUNGI

Occurrence of Fungi Causing Decay

Heart-rot fungi can usually be identified from the sporophores or fruiting bodies that develop on the infected trees. However, most of the fungi associated with decay in oaks rarely produce sporophores on living trees *(1)*, and it is seldom possible to determine the causal fungus from the type of decay alone. Therefore, to identify the fungi isolated from decay columns, it was necessary to compare pure cultures of these unidentified isolates

with isolates from sporophores maintained in the reference collection of cultures at the Center for Forest Mycology Research at Madison, Wisconsin.

Twenty-nine species of fungi associated with decay of oak in the central hardwood region were isolated and identified (table 1). Their relative frequency was calculated by expressing the number of isolates of each fungus as a percentage of the total number of isolates. Most frequently isolated fungi were *Poria andersonii* (Ell. & Ev.) Neuman, *Stereum frustulatum* (Pers. ex Fr.) Fckl., *S. gausapatum* (Fr.) Fr., *Polyporus compactus* Overh., Unknown "H", *Irpex mollis* Berk. & Curt., *Hericium* spp., *Polyporus sulphureus* Bull. ex Fr., and *Poria oleracea* Davidson & Lombard. These nine species accounted for over 80 percent of the 715 infections identified. They were generally well distributed among the four species of oaks in the study.

Fungi associated with decay in the heartwood normally do not attack the sapwood. The decay is compartmentalized in tissues present at the time of wounding *(8)*. Thus, trees may grow to maturity and outwardly

Table 1.—*Occurrence of fungi causing decay in living oaks in the central hardwood region, by tree species and type of rot*

Fungus species	Identified infections					Frequency of infection
	Scarlet oak	Black oak	White oak	Chestnut oak	Total	
	No.	*No.*	*No.*	*No.*	*No.*	*Percent*
			WHITE ROT			
Poria andersonii (Ell. & Ev.) Neuman	12	56	36	13	117	16.36
Stereum frustulatum (Pers. ex Fr.) Fckl.	54	32	7	6	99	13.85
Stereum gausapatum (Fr.) Fr.	28	28	10	6	72	10.07
Polyporus compactus Overh.	15	37	5	5	62	8.67
Unknown "H"[1]	37	2	8	2	49	6.85
Irpex mollis Berk. & Curt.	2	26	13	7	48	6.71
Hericium spp.	4	14	24	3	45	6.29
Polyporus obtusus Berk.	2	3	8	2	15	2.10
Armillaria mellea (Fr.) Quél.	2	3	4	3	12	1.68
Merulius tremellosus Schrad. ex Fr.	2	3	2	3	10	1.40
Hymenochaete rubiginosa Dicks. ex Lév.	8	1	—	—	9	1.26
Polyporus dryophilus Berk.	4	—	2	3	9	1.26
Polyporus versicolor L. ex Fr.	3	3	2	—	8	1.12
Stereum complicatum (Fr.) Fr.	—	3	2	1	6	.84
Polyporus frondosus Dicks. ex Fr.	3	—	2	—	5	.70
Polyporus adustus Willd. ex Fr.	—	2	—	2	4	.56
Poria mutans Pk.	3	—	—	—	3	.42
Pleurotus ostreatus (Jacq. ex Fr.) Kumm.	2	—	—	—	2	.28
Stereum subpileatum Berk. & Curt.	1	1	—	—	2	.28
Rigidoporus vitreus (Pers. ex Fr.) Dounk.	—	—	—	2	2	.28
Corticium galactinum (Fr.) Burt	—	1	—	—	1	.14
Polyporus fissilis Berk. & Curt.	—	—	1	—	1	.14
Steccherinum setulosum (Berk. & Curt.) Miller	—	1	—	—	1	.14
Total	182	216	126	58	582	81.40
			BROWN ROT			
Polyporus sulphureus Bull. ex Fr.	41	12	3	4	57	7.97
Poria oleracea Davidson & Lombard	35	5	—	—	40	5.59
Poria cocos (Schw.) Wolf	4	5	1	6	16	2.24
Polyporus spraguei Berk. & Curt.	13	3	—	—	16	2.24
Poria nigra (Berk.) Cke.	1	2	—	—	3	.42
Fistulina hepatica (Huds.) Fr.	1	—	—	—	1	.14
Total	95	27	4	7	133	18.60
All species	277	243	130	65	715	100.00

[1]Misidentified as *Corticium lividum* Pers. ex Fr. in U. S. Dep. Agr. Tech. Bull. 785, Fungi Causing Decay in Living Oaks in the Eastern United States and their Cultural Identification, by Ross W. Davidson, W. A. Campbell and Dorothy B. Vaughn. 1942.

appear healthy and vigorous. *Irpex mollis*, however, differs from most other wood-rotting fungi, because it also attacks living sapwood and the cambium, causing cankers to form on the trunk.

Wood-decay fungi are divided into two types—the white rots and brown rots. As implied by their names, the two types can be distinguished by the color of the decayed wood. The brown rots are not so numerous in oaks as the white rots. Over 80 percent of the total number of infections were due to white-rot fungi, and seven of the nine most commonly isolated fungi were members of this group (table 1).

Based on their position in the tree, decays are also divided into two categories, trunk rot and butt rot. Most of the fungi isolated from oak can cause both types of rot (table 2). However, there are some species (*Armillaria mellea* [Fr.] Quél., *Polyporus frondosus* Dicks. ex Fr., *P. spraguei* Berk. & Curt., and *Poria cocos* [Schw.] Wolf) that cause root and butt rots that rarely extend more than a few feet up the bole (fig. 2). Infected stumps serving as a food base may be important infection sources of root- and butt-rot fungi. Although the number of root and butt infections was less than half the number of trunk infections, the former accounted for a greater

Table 2.—*Fungi causing decay in oak in the central hardwood region and their relation to the portion of the tree bole affected*

Fungus species	Identified infections			Decay volume		
	In butt[1]	In trunk	Total	In butt[1]	In trunk	Total
	No.	*No.*	*No.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*
			WHITE ROT			
Poria andersonii	13	104	117	22.19	69.93	92.12
Stereum frustulatum	22	77	99	13.41	47.70	61.11
Stereum gausapatum	19	53	72	25.78	39.49	65.27
Polyporus compactus	10	52	62	18.73	22.90	41.63
Unknown "H"	19	30	49	16.84	7.48	24.32
Irpex mollis	1	47	48	11.78	28.28	40.06
Hericium spp.	27	18	45	40.24	4.47	44.71
Polyporus obtusus	6	9	15	.77	5.42	6.19
Armillaria mellea	12	—	12	12.89	—	12.89
Merulius tremellosus	9	1	10	18.80	.07	18.87
Hymemochaete rubiginosa	—	9	9	—	2.11	2.11
Polyporus dryophilus	1	8	9	6.38	13.49	19.87
Polyporus versicolor	2	6	8	8.45	.61	9.06
Stereum complicatum	—	6	6	—	.36	.36
Polyporus frondosus	5	—	5	3.58	—	3.58
Polyporus adustus	3	1	4	4.04	.05	4.09
Poria mutans	—	3	3	—	1.50	1.50
Pleurotus ostreatus	—	2	2	—	.04	.04
Stereum subpileatum	1	1	2	2.18	1.02	3.20
Rigidoporus vitreus	—	2	2	—	.14	.14
Corticium galactinum	—	1	1	—	.51	.51
Polyporus fissilis	1	—	1	1.77	—	1.77
Steccherinum setulosum	1	—	1	—	10.48	10.48
Total	152	430	582	207.83	256.05	463.88
			BROWN ROT			
Polyporus sulphureus	32	25	57	101.36	58.98	160.34
Poria oleracea	7	33	40	20.29	12.19	32.48
Poria cocos	16	—	16	47.32	—	47.32
Polyporus spraguei	16	—	16	16.41	—	16.41
Poria nigra	—	3	3	—	5.81	5.81
Fistulina hepatica	1	—	1	2.67	—	2.67
Total	72	61	133	188.05	76.98	265.03
All species	224	491	715	395.88	333.03	[2]728.91

[1]Decay originating at stump height or below was considered as butt decay.
[2]Decay volume associated with identified infections; in addition there were 446.57 cubic feet of decay volume in which the causal fungi were unknown.

Figure 2.—Fruiting bodies of the honey mushroom, *Armillaria mellea* (Fr.) Quél., at the base of an oak tree infected with butt rot.

Table 3.—*Relative importance of fungi causing decay in living oaks in the central hardwood region, by tree species and type of rot*

Fungus species	Decay volume				Total identified decay volume	
	Scarlet oak	Black oak	White oak	Chestnut oak		
	Cu. ft.	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Percent*
			WHITE ROT			
Poria andersonii	3.27	44.21	31.34	13.30	92.12	12.64
Stereum gausapatum	28.05	18.38	9.55	9.29	65.27	8.95
Stereum frustulatum	29.36	24.18	4.01	3.56	61.11	8.38
Polyporus compactus	12.03	19.71	3.77	6.12	41.63	5.71
Hericium spp.	.46	26.96	16.79	.50	44.71	6.13
Irpex mollis	.48	15.20	10.08	14.30	40.06	5.49
Unknown "H"	16.72	4.58	1.68	1.34	24.32	3.34
Polyporus dryophilus	11.19	—	.80	7.88	19.87	2.73
Merulius tremellosus	6.03	6.75	5.04	1.05	18.87	2.59
Armillaria mellea	1.18	.68	5.88	5.15	12.89	1.77
Steccherinum setulosum	—	10.48	—	—	10.48	1.44
Polyporus versicolor	8.48	.26	.32	—	9.06	1.24
Polyporus obtusus	.10	.86	3.77	1.46	6.19	.85
Polyporus adustus	—	3.83	—	.26	4.09	.56
Polyporus frondosus	3.52	—	.06	—	3.58	.49
Stereum subpileatum	1.02	2.18	—	—	3.20	.44
Hymenochaete rubiginosa	2.00	.11	—	—	2.11	.29
Polyporus fissilis	—	—	—	1.77	1.77	.24
Poria mutans	1.50	—	—	—	1.50	.21
Corticium galactinum	—	.51	—	—	.51	.07
Stereum complicatum	—	.32	.04	—	.36	.05
Rigidoporus vitreus	—	—	—	.14	.14	.02
Pleurotus ostreatus	.04	—	—	—	.04	.01
Total	125.43	179.20	93.13	66.12	463.88	63.64
			BROWN ROT			
Polyporus sulphureus	94.72	59.16	4.52	1.94	160.34	22.00
Poria cocos	2.41	26.09	3.00	15.82	47.32	6.49
Poria oleracea	31.07	1.41	—	—	32.48	4.45
Polyporus spraguei	15.22	1.19	—	—	16.41	2.25
Poria nigra	4.36	1.45	—	—	5.81	.80
Fistulina hepatica	2.67	—	—	—	2.67	.37
Total	150.45	89.30	7.52	17.76	265.03	36.36
All species	275.88	268.50	100.65	83.88	728.91	100.00

[1]Decay volume associated with identified infections; in addition, there were 446.57 cubic feet of decay volume in which the causal fungi were unknown.

amount of cull—395.88 cubic feet compared to 333.03 cubic feet in the trunk.

Relative Importance of Fungi Causing Decay

Over one-fifth (22 percent) of the total decay volume for which fungi were identified was caused by *Polyporus sulphureus*, the sulfur fungus (table 3). This fungus species, widespread in the United States on both hardwoods and conifers, was isolated from all four oak species.

Other fungi associated with appreciable decay losses were *Poria andersonii*, *Stereum gausapatum*, *S. frustulatum*, *Hericium* spp., *Polyporus compactus*, *Poria cocos*, and *Irpex mollis*. These seven species, together with *Polyporus sulphureus*, accounted for 552.56 cubic feet, or about 75 percent, of the total identified decay volume.

DECAY RELATIONS

Entry Courts and Infection

In oaks, the central core of heartwood is surrounded by living sapwood, which is protected by the bark. Since sapwood is ordinarily not attacked by heart-rot fungi, the sapwood and bark protect the heartwood from attack. Before most heart-rot fungi can successfully invade the heartwood, a wound that penetrates to the heartwood or dead tissue extending to the heartwood is required (fig. 3).

Tree wounds are caused in a number of ways. In the central hardwood region, we found that fire surpassed all other causes of wounds through which heart-rot fungi may enter. Almost 25 percent of all infections originated at fire scars, and over 40 percent of the total decay volume was associated with fire scars (table 4). Because of the large area of exposed wood and the long period of time required for the growth of protective callus, fire scars are particularly vulnerable to decay (fig. 4).

Dead branch stubs were second only to fire scars as entry points for heart-rot fungi (fig. 5). However, decay loss was only about one-third that of fire scars, since many of the infections from fungi entering through dead branch stubs frequently result in relatively minor amounts of decay. Scarlet oak, which tends to retain its branches longer than the other oak species, was particularly vulnerable to infection entry through branch stubs.

The comparative effectiveness of defect indicators visible on the tree bole as indicators of hidden decay is shown in table 5. Open fire scars were the only indicator with which hidden decay was consistently found. However, decay was associated in two out of three trees with either closed fire scars or dead or dam-

Figure 3.—Manner in which heart-rot fungi may enter a tree. From *Pathology of Trees and Shrubs*, by T. R. Peace, reproduced by special permission and courtesy of the Forestry Commission of Great Britain.

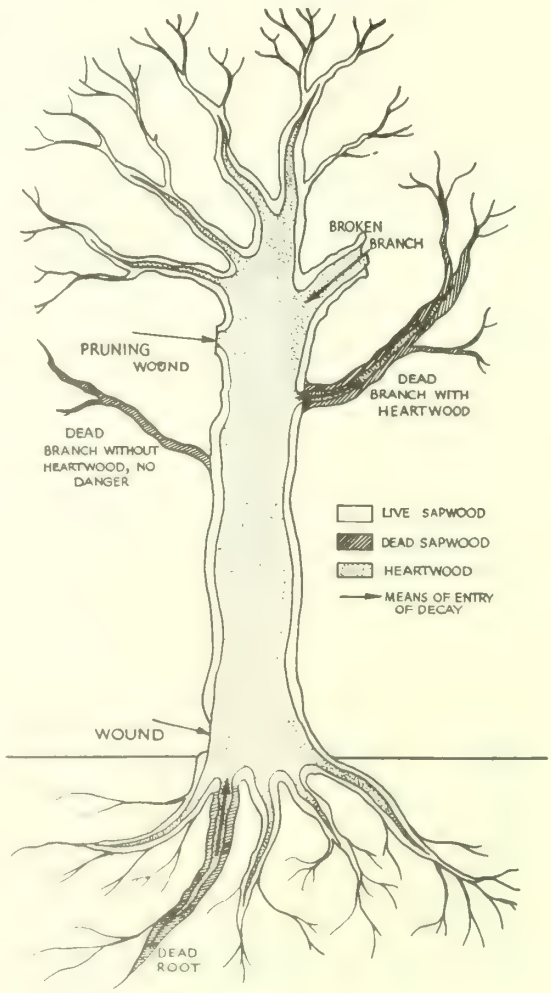

Table 4.—*Relationship of entry courts to incidence of infection and volume of decay*

Infection court	Infections		Volume of decay	
	No.	*Percent*	*Cu. ft.*	*Percent*
Fire scars	446	24.45	470.94	40.06
Dead branch stubs	402	22.04	158.07	13.45
Branch bumps	238	13.05	130.28	11.08
Insect wounds	181	9.92	52.96	4.51
Parent stumps	168	9.21	111.58	9.49
Mechanical injuries	101	5.54	48.89	4.16
Open branch stub scars	99	5.43	81.61	6.94
Damaged or dead tops	96	5.26	76.56	6.51
Roots	70	3.84	35.83	3.05
Woodpecker injuries	23	1.26	8.76	.75
Total	1,824	100.00	1,175.48	100.00

Figure 4.—A fire-scarred black oak cut lengthwise to show decay in trunk.

Figure 5.—A black oak with a dead branch stub about 12 feet up trunk.

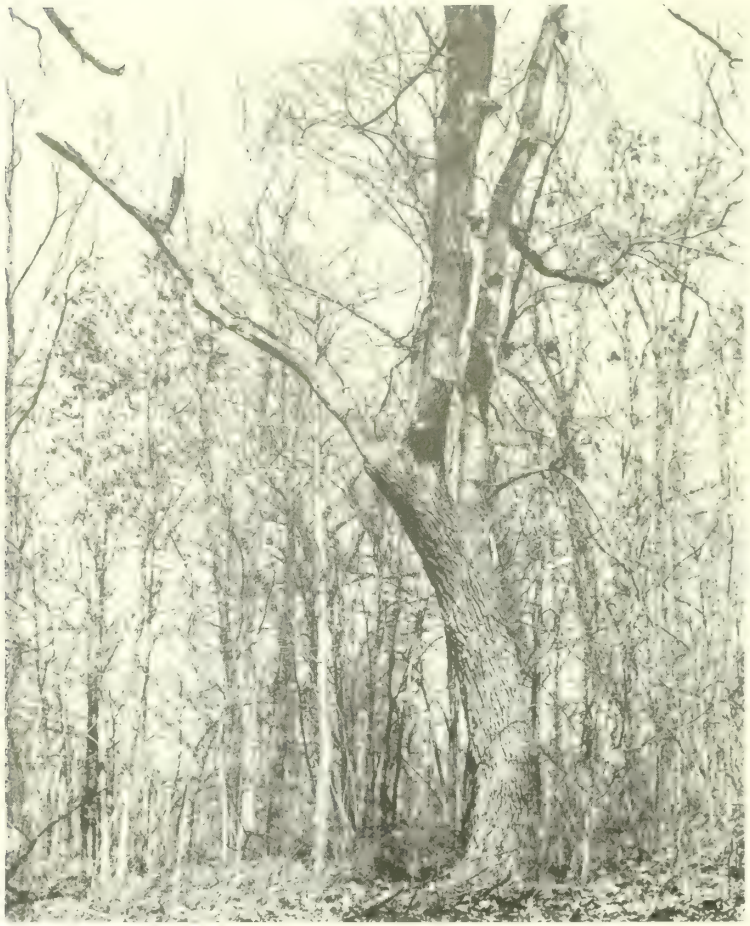

Table 5.—*The comparative effectiveness of visible indicators of decay*

Indicator	Frequency of occurrence			Frequency of decay
	Decay present	Decay absent	Total	
	No.	*No.*	*No.*	*Percent*
Open fire scars	77	1	78	98.72
Closed fire scars	369	205	574	64.29
Dead or damaged tops	96	62	158	60.76
Unsound branch stubs[1]	60	135	195	30.77
Mechanical injuries	101	295	396	25.50
Branch bumps[1]	45	149	194	23.20
Open branch stub scars	99	707	806	12.28
Unsound branch stubs[2]	102	841	943	10.82
Stem bulges	55	459	514	10.70
Sound branch stubs[1]	24	221	245	9.80
Branch bumps[2]	111	1,484	1,595	6.96
Woodpecker injuries	23	866	889	2.59
Sound branch stubs[2]	50	2,231	2,281	2.19
Unsound branch stubs[3]	95	4,437	4,532	2.10
Branch bumps[3]	82	5,864	5,946	1.38
Sound branch stubs[3]	71	11,331	11,402	.62

[1]4 inches and more in diameter.
[2]2-4 inches in diameter.
[3]1-2 inches in diameter.

aged tops, and one out of three trees with unsound branch stubs 4 inches and more in diameter.

Decay in Relation to Age and Diameter

Gross and decay volumes of the four oak species were calculated and analyzed to determine the relationship between percent decay and tree age and diameter. Estimates of the percent of decay for trees of various ages and diameters are shown in tables 6 and 7. These estimates were obtained by fitting a weighted polynomial regression line to the actual data. The standard error of each estimate is also given in the tables.

The percentage of decay volume increased progressively with increasing age. As trees become older, the relative proportion of heartwood becomes greater, opportunities for infection multiply, and the rate of wound healing becomes slower. But important differences in decay occur between stands of the same age, depending on prevalence of wounds, time of wounding, seedling or sprout origin of the trees, and site *(6)*.

The percentage of decay volume also increased progressively with increasing diameter.

Estimated decay percentages for the various oak species differ considerably. Scarlet oak had the greatest amount of decay, followed by black oak, chestnut oak, and white oak, in that order (fig. 6).

Table 6.—*Estimated decay in oak stands in the central hardwood region, by age and species*

Age *(years)*	Scarlet oak		Black oak		Chestnut oak		White oak	
	Decay	Standard error of estimate	Decay	Standard error of estimate	Decay	Standard error of estimate	Decay	Standard error of estimate
	Percent		*Percent*		*Percent*		*Percent*	
20	0.80	1.13	0.00	.28	0.00	1.17	0.00	.15
30	1.69	.63	.39	.22	.00	.71	.13	.12
40	2.81	.39	1.23	.17	.03	.42	.61	.10
50	4.15	.42	2.07	.15	1.12	.34	1.10	.09
60	5.72	.52	2.92	.18	2.08	.37	1.58	.12
70	7.51	.62	3.76	.23	2.92	.39	2.06	.15
80	9.53	.79	4.69	.30	3.64	.38	2.54	.19
90	11.77	1.13	5.44	.38	4.23	.42	3.02	.23
100	14.24	1.66	6.29	.45	4.70	.63	3.50	.27
110	16.94	2.38	7.13	.53	5.04	1.02	3.98	.31

Table 7.—*Estimated decay in oak stands in the central hardwood region, by diameter and species*

Diameter *(inches)*	Scarlet oak		Black oak		Chestnut oak		White oak	
	Decay	Standard error of estimate	Decay	Standard error of estimate	Decay	Standard error of estimate	Decay	Standard error of estimate
	Percent		*Percent*		*Percent*		*Percent*	
4.5	3.73	1.09	1.59	0.32	0.69	0.63	1.07	0.18
6.5	4.25	.62	1.93	.24	1.52	.45	1.25	.14
8.5	4.73	.45	2.28	.19	2.35	.33	1.43	.14
10.5	5.19	.51	2.62	.18	3.18	.34	1.61	.20
12.5	5.62	.61	2.97	.22	4.02	.47	1.79	.27
14.5	6.01	.70	3.31	.29	4.85	.66	1.96	.34
16.5	6.38	.87	3.66	.37	5.68	.87	2.14	.43
18.5	6.71	1.23	4.00	.45	—	—	2.32	.51
20.5	7.01	1.80	4.35	.54	—	—	2.50	.60
22.5	7.29	2.58	4.69	.64	—	—	2.68	.68

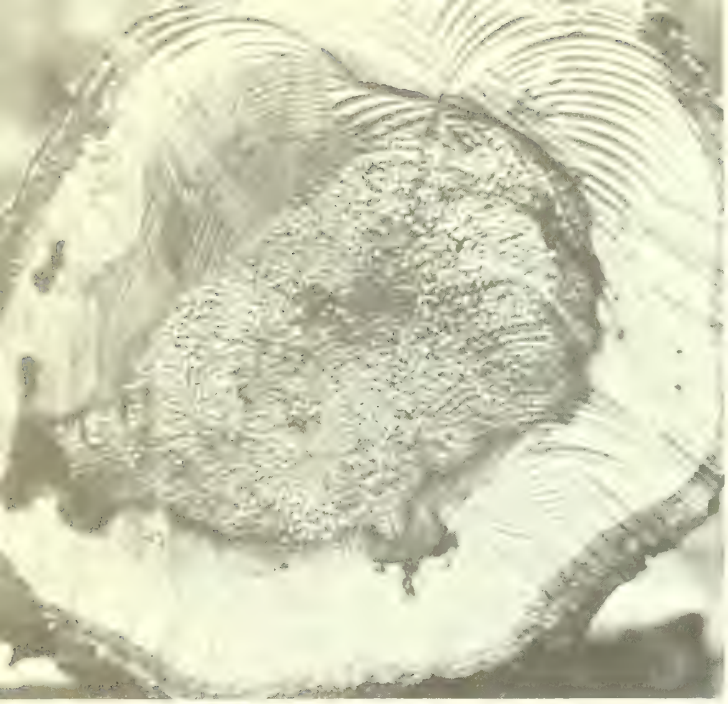

Figure 6.—Heart rot in a scarlet oak log.

CONTROL

Although heart rot causes considerable loss in oak stands in the central hardwood region, these losses can be reduced.

We found that many infections followed fire injury. Therefore, more adequate fire protection can greatly reduce the incidence of decay in these stands.

Improved management and silvicultural practices can further reduce losses. Many oak stands are of sprout origin. Butt rot can be reduced by thinning oak sprouts before heartwood forms at the base to act as a bridge for decay from the parent stump. Lower sprouts should be favored over the more decay-susceptible sprouts higher on the trunk *(7)*.

Control of stand density can also lessen decay hazard through regulation of branch size and reduction of wind and ice damage. Density in young stands should be high enough so that branches do not form heartwood before being shaded out *(4)*.

Rotations (number of years trees are grown until harvested) should be sufficiently short so that the trees are cut before decay becomes a problem.

And even-aged management, utilizing clearcutting to regenerate stands, will cause less felling and skidding injuries and subsequently less decay.

CONCLUSIONS

Although 29 species of fungi were found associated with decay in oak in the central hardwood region, 9 species accounted for over 80 percent of the identified infections. The most commonly isolated decay fungi were *Poria andersonii*, *Stereum frustulatum*, *S. gausapatum*, *Polyporus compactus*, Unknown "H", *Irpex mollis*, *Hericium* spp., *Polyporus sulphureus*, and *Poria oleracea*. *Polyporus sulphureus* caused more decay volume loss than any of the other species.

Fire scars were the most important entry courts for decay fungi. Almost 25 percent of all infections originated at fire scars and over 40 percent of the total decay volume was associated with fire scars.

Decay volume increased progressively with increasing age and diameter. Scarlet oak had the greatest amount of decay, followed by black oak, chestnut oak, and white oak.

The considerable losses caused by decay fungi in oak stands in the central hardwood region can be reduced by better fire control and improved management and silvicultural practices.

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THE FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

The Role of FOREST SITE *in* FERTILIZER *Response*

by Raymond E. Leonard
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U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-243
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FOREST FERTILIZATION is one of many cultural practices available for intensive forest-resource management. It is a potentially useful practice for improving quantity or quality of goods or services, whether the management objectives involve timber, fiber, wildlife, recreation, or water. As with other cultural practices, it should be used if it helps to meet management objectives in an efficient manner. Also, as with other practices, it involves a commitment of investment on the site; it may result in an array of side effects in the ecosystem; and it must fit logically into long-range management plans.

There are two general philosophies about the role of forest fertilization in forest-resource management. One advocates the relative widespread use of a so-called general "complete" fertilizer formulation, based on the premise that one or more parts of the formulation may be beneficial for meeting the predetermined objectives, and that the remainder will be incorporated into the ecosystem and dissipated with time. This philosophy involves no lengthy and costly diagnosis of the forest site. And it allows the most widespread and — in terms of cost per unit area — the least expensive means of application: aerial broadcast. With this philosophy, consideration of forest site condition is minimal.

We reject this philosophy as irresponsible. We believe that it is not in the best interests of mankind because it results in the inefficient use of resources and may have deleterious effects on the quality of the environment.

The second philosophy advocates use of specific fertilizer formulations that alleviate site-organism limitations and meet managerial objectives. This more responsible philosophy implies a greater expenditure of time and funds to obtain the necessary information upon which to base decisions about all aspects of an efficient fertilization program. With this philosophy, the management objectives and site conditions become the driving forces in the decision-making processes. The proper diagnosis of possible fertilizer needs may be the most time-consuming and expensive portion of such a program. This may be appropriate, because proper diagnosis is the key to

success of a fertilization program in meeting management objectives. This philosophy is compatible with today's concerns for environmental quality.

FOREST SITE -- ORGANISM RELATIONS

Site, as considered historically, is synonymous with the term "environment". It is defined as the sum total of all factors and substances affecting the growth, structure, and reproduction of an organism. This includes both the physical and biotic aspects of the environment.

A particular site may be considered as an energy system. Energy assumes several forms, including chemical, radiant, and thermal; and conversion from one form to another is possible — for example, radiant energy to chemical energy, or chemical energy to thermal energy. As stated in the Law of Conservation of Energy, energy cannot be created or destroyed; it can only be redistributed or changed in form. Thus, in a given geographic area, natural production of the biota, whether macro- or micro-plants or animals, will be limited ultimately by the energy level available in that area.

Traditionally, cultural treatments to forested areas — such as thinnings, weedings, or animal-population control — are manipulative mechanisms designed to redistribute the available energy to favor certain desired portions of the biotic community. However, cultural treatments such as fertilization are designed to change or add to the level of energy in a given area.

The utilization of the energy level on a site depends upon the total complex of organism and community characteristics and influences. In considering the impact of the physical environment on organisms, one must consider the roles of the physical environmental factors according to the concepts of limiting factors, compensating factors, and the holocenotic environment, along with the implied temporal and spatial significance embodied in these concepts. The concept of the holocenotic environment, in particular, recognizes that interactions take place among the environmental factors and between these factors and the organisms in the environment. Therefore, each factor must be considered in relation to all other factors and the tolerance limits of the organisms.

Site-organism relationships include interactions at the organismic and community levels. The adaptability of an organism to a site depends upon its requirements, tolerances, and efficiency. *Requirement* refers to the quantities or intensities of the energy and physical environment factors, including nutrient-element levels, required to sustain life in the organism at some near-optimum level. *Tolerance* refers to the resistance of the organism to excess or deficiency of one or more of these environmental factors. *Efficiency* refers to the capacity of the organism to utilize these resources of the site.

The composition of a forest community depends not only upon the site-organism interactions, but also upon the ability of organisms to compete effectively for the necessary energy. Competition within the community occurs as intraspecific competition and as interspecific competition. Competition in all plant communities occurs both above ground and below ground, and the importance of each type depends on the stage of community development — for example, tree seedling-herbaceous growth competition, interspecific tree competition, etc.

FOREST SITE ASSESSMENT

The objective of cultural treatments, whether they be energy-manipulative or energy-additive, is to change the character of the site to meet certain objectives. Determination of whether or not these objectives have been or can be met efficiently depends on quantitative assessment of the site and site-organism relations, both before and after treatment.

Thus the quantitative assessment of forest site is an essential initial phase of a successful and responsible forest-fertilization program to determine: (1) the nature and degree of the site limitations, and (2) what must be done

to meet stated objectives. Similar quantitative assessment is also essential after treatment for evaluating the degree of success attained.

For a successful fertilization program, therefore, it is essential for managers to understand the site conditions sufficiently so they can ascertain: (1) whether nutrient-element limitations are controlling the quantity or quality of goods or services, and not some other environmental factors, physical or biotic in nature; (2) what the specific nutrient-element limitations are; and (3) what are the appropriate or efficient levels of the nutrient elements to add to correct the limitation.

Fertilizing a site triggers a host of complex and dynamic events, the results of which eventually affect the objectives sought if the treatment is to be considered a success. However, this measure of success may not occur until a few years after treatment, depending upon the nutrient elements involved and the site-organism relations. An appreciation of these events and an understanding of the processes involved are essential inputs into management decision-making. This knowledge can be gained only by using stringent quantitative assessment techniques designed to monitor the total environment and site-organism relationships.

Forest fertilization may be used for a great variety of reasons, and the measure of response depends on the treatment objectives — timber production, seed production, vegetative erosion control, vegetation health and vigor, browse production, etc. Each objective requires its own evaluation for possible fertilizer needs and measures of response. Though many examples could be described, it will suffice to say that, where control of abiotic diseases is the objective, measures of increased wood production may not be appropriate. Or, where establishment of vegetation to control trail, road, and riparian erosion hazards is the objective, measures of water quality and quantity may be very appropriate.

Regardless of the measures of response and the objectives that are sought, the adequacy of sampling, the accuracy and precision of the analyses, and the interpretation of results pose numerous problems. Questions about what, how, and when to sample, the types of analyses employed, the actual expressions of results, the interpretation of results, and the extrapolation of interpretations need careful consideration. Recognition of spatial and temporal variations in relation to site-organism conditions as well as type of treatment is essential.

INCREASED WOOD PRODUCTION

Site Assessment

If we restrict ourselves to only one of many possible objectives for a forest-fertilization program — say increased wood production — we have a sufficiently difficult task to consider. Fertilizer additives have a marked effect on the entire ecosystem, and in time they will cause in the system various changes besides the response that is sought. The magnitude of these changes depends on the site conditions, organism characteristics, and other cultural practices performed in conjunction with the fertilization program.

Researchers have for too long selected the least productive sites for making fertilizer trials. Trials on such sites are extremely valuable when accompanied with detailed monitoring of the environment and organisms, because they contribute to the body of knowledge in physiological ecology. But forest managers would not concentrate their fertilization program efforts on such sites. For an economic gain, fertilization programs that increase product quantity or quality from "good" to "very good" on a relative scale are far better than those that result in an increase from "very poor" to "intermediate".

Therefore the expression of treatment responses in relative terms alone is of limited value. If we say that 100- to 200-percent responses in increment can be obtained with a particular fertilizer additive on a particular site, this is of limited practical significance without specific reference to absolute increment data. The old adage, "100-percent increase of near-nothing is still near nothing", applies in this case.

The future of forest-fertilization programs

to obtain increased wood production depends upon evaluation in terms of absolute responses in merchantable products. We must learn to evaluate forest-fertilization programs to determine the feasibility of converting relatively good sites to still better sites, of increasing marketable yield, of improving marketable product quality, of shortening rotations, or of meeting whatever the management objectives may be.

This places additional burdens on researchers because it requires more sophisticated site-evaluation techniques and experimental designs to quantify a statistically significant, modest relative response as may be expected of good sites to make them still better, than those required to demonstrate a large relative response as may be the case on very poor sites to make them intermediate in productivity. Yet this so-called "modest response", if real (*vs.* an artifact of the design and procedures employed), may provide the margin that would make the fertilization program important to management.

These burdens on researchers also include consideration of several other factors, including measurement techniques and diagnostic criteria. Responses should be measured in actual units upon which the decision-making processes hinge — volume, dry-weight, etc. — rather than diameter at 1.5 m, height or height increments. Many of the currently used indirect measures are not reliable or sensitive enough to be used to precisely measure increased marketable yield. Careful judgment must be made on the intensity of response measurements and the practical or economic feasibility of such measurements. This latter point implies consideration not only of the type of instrumentation used, but also of the frequency of measurements and the time-from-treatment effects.

The state of the art today does not permit the determination of specific nutrient-element needs based on current site-evaluation techniques. Current site-classification schemes have developed at two intensity levels. The first of these, in vogue in the past two decades in the United States, is the *extensive* scheme that utilizes primarily the readily measurable edaphic and physiographic variables, with emphasis on soil moisture availability as the determinant of site quality. Few of these studies include soil fertility considerations. This type of scheme has concentrated on indirect measures — soil texture, structure, depth, color, etc. — of the prime properties of site that are of major importance to organism needs, rather than on the energy relations and the moisture, aeration, and nutrient element availabilities. And some indirect measures of site conditions are often not included in the extensive classification that do have importance in the nutrient-element status; for example, degree of erosion or magnitude of previous land use or abuse.

The other intensity level is represented by the very detailed *intensive* studies of the growth requirements of a particular community on a particular site. This involves considerable monitoring of the organisms and environmental variables. Neither scheme, extensive or intensive, has direct applicability to the evaluation of large areas for fertilization; the first is too general and the latter is to restrictive. The role of classification of sites for operational forest-fertilization programs should lie within these extremes; it should be intensive enough to provide adequate information for fertilizer prescriptions and extensive enough to make this information applicable to large areas.

Appropriate diagnostic techniques must be developed to fulfill these site-classification criteria. For many years it has been advocated that the only positive test for determining nutrient-element needs is to establish fertilizer trials of appropriate design to evaluate the need for various nutrient elements, singly and in combination. However, such trials have limitations due to the length of time required to obtain results, the sophistication of response measurements, the determination of duration of response, and the dependency upon year-to-year variation in the physical environmental conditions; for example, precipitation amounts and distribution patterns.

Various diagnostic techniques such as greenhouse cultures, vegetation visual symptoms, and soil and plant tissue analyses are being used with varying degrees of success, depending on their intended use. However, all these

techniques have interpretive limitations in determining the need for fertilization and the responses to it.

Effects of Treatments

As previously stated, addition of fertilizer to a site results in a host of complex and dynamic changes, some sought in the managerial objectives and some possibly detrimental to those objectives. This type of treatment can affect the composition of both the macro- and micro-biota of a forest community by altering competitive-efficiency relationships within the community and by changing vegetation succession trends.

In such cases the benefits of increased wood production of the desired tree species may be offset in part by the possible stimulation of competitive organisms, which require additional cultural inputs to counteract this undesirable side effect of the fertilization treatment. Such complementary treatments as brush control, disking the sod, thinning, and chemical treatment of understory vegetation also have an influence on the objectives sought; and the magnitude of their influence depends on the total environmental conditions of the area. Forest-fertilization programs must be considered as integral parts of the long-range management considerations for the area in question.

Our experiences at the Charles Lathrop Pack Forest Environmental Laboratory in New York State have indicated that the environment within a forest stand is influenced by the structure, age, species composition, and density of the stand. A more rapidly growing stand will be made up of larger trees with greater crown masses and greater root distribution throughout the soil than a slower growing stand of comparable age, species composition, and stocking. The dry-weight or biomass differences in these two stands affect the amount and distribution of precipitation reaching the ground, the wind activity, and the solar-radiation distribution as well as the patterns of temperature and humidity variation. An appreciation of these relationships helps us to understand the energy budget of the forest as it relates to the effects of cultural treatments within forest stands.

If rapidly growing and slowly growing stands receive similar energy inputs of solar radiation at the crown surfaces, they have different energy-distribution patterns within. The more rapidly growing stand would be composed of taller trees with greater crown masses, having greater surface area per unit area of land. As a result, this rapidly growing stand would intercept more precipitation; thus less would reach the understory and forest floor. Even with the greater production of biomass, this rapidly growing stand may not have a greater forest floor dry weight because of a richer soil fauna and a higher rate of organic-matter decomposition than the slowly growing stand. The net precipitation reaching the mineral soil rooting zone, therefore, may in fact remain less in the rapidly growing stand.

Turbulent air flow within the crowns of the rapidly growing stand, because of the greater crown mass and foliage weight, would be less than in the slowly growing stand.

The rapidly growing stand, which would have foliage with darker, healthier green color, would absorb more of the incoming solar radiation; and the proportion of incoming solar radiation that reaches the forest floor would be less than in the slowly growing stand.

Because of the larger crown mass, the rapidly growing stand would have lower maximum and higher minimum air temperatures within and below the crown. On clear summer days the slowly growing stand would warm more rapidly in early morning. By early afternoon, however, temperatures within the crowns would be similar for the two stands. In late afternoon, the sparse canopy of the slowly growing stand would cool more rapidly; and in the evening this stand would be cooler.

Below the canopy, higher air temperatures would prevail in the slowly growing stand until about noon. In afternoon the temperature below the canopy would start dropping so that by evening these temperatures would be about the same in both stands. The sparse crown in the slowly growing stand would allow continued cooling at a faster rate than in the rapidly growing stand, so that at midnight the slowly growing stand would be cooler.

In the morning, soil temperatures on clear summer days would be similar in the two stands. However, increased solar radiation reaching the forest floor will raise the near-surface soil temperature of the slowly growing stand above that in the rapidly growing stand for the remainder of the day. A similar pattern, with increasing lag time with soil depth, would persist in the A and B soil horizons. From evening until next morning there will be differential cooling in the soils of the two stands until similar near-surface soil temperatures are again reached in the two stands, in accordance with the ambient temperature.

Related to the differences in wind and temperature, the humidity in the lower crown and stem space of the rapidly growing stand would be higher. Therefore evaporation from the forest floor would be less in this stand, whereas transpiration would be greater because of tree crown and root characteristics of this more rapidly growing stand. The combination of these two water losses may result in similar moisture levels in the soils of the two stands.

The marked amplitude of the climatic variables in the slowly growing stand affects this stand's ability to utilize the energy inputs as efficiently as in the rapidly growing stand. In a sense, with wood production as the objective, energy in the slowly growing stand is wasted by being expended for non-productive purposes.

Without treatment in stands like the slowly growing stand, the inefficient system persists, and "the poor-get-poorer and the rich-get-richer". If the site conditions of the poor stand are assessed correctly by appropriate diagnostic techniques as nutrient-element limiting for near-optimum growth, proper fertilization with the suboptimal nutrient will serve as a catalyst to alter the inefficient system. Such a treatment for the slowly growing stand may trigger a conversion to that approaching the more efficient energy utilization of the rapidly growing stand.

When appropriately used on nutrient-element suboptimal sites, fertilization markedly influences the energy balance of forest stands, further demonstrating the interaction among environmental components.

RECOMMENDATIONS

A major task in developing a successful forest-fertilization program is the proper assessment of the site conditions and organism relations so that efficient site-dependent fertilizer prescriptions may be developed for the most effective and least wasteful use of fertilizer additives.

This would result in applications of the right fertilizers in the right forms at the right time at the right rate to meet the objectives sought without endangering the quality of the environment. This implies fertilizer prescriptions that would depend upon the physical environment conditions, competitive plant and animal life, and stage of development of the vegetation to be treated. Such prescriptions must also be an integral part of the long-range intensive management program for an area so that the prescription may be modified to be compatible with manipulative cultural treatments.

Site conditions determine (1) the native nutrient-element resource; (2) the complex and dynamic processes that regulate the availability of these elements in this resource — chemical and biological reactions; and (3) nutrient-element cycling. It is essential that researchers perfect the diagnostic techniques necessary to properly assess the nutrient-element resource and the processes of availability within it and effectively meet management's objectives.

Detailed information is also essential about the specific requirements and tolerances of organisms to serve as a basis for proper site assessment and fertilizer prescriptions. Of primary concern is the mobility of the native nutrient elements and those from the fertilizer additions within the soil volume in relation to the patterns of rhizospheric absorbing surfaces and nutrient uptake. Such information, together with the quantification of related site conditions, would help in management's decision-making processes.

More work is needed in greenhouse culture and soil and tissue analyses, not only to develop so-called critical nutrient-element levels of species, but also to develop the range of near-optimal levels of nutrient elements and

nutrient-element interactions with total environment conditions — energy status and levels of available moisture and aeration. Such fundamental information is necessary as inputs into management decision-making processes to determine the practicality of forest fertilization that may increase the quantity or quality of goods and services.

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FORESTRY RETURNS EVALUATED

for uneven-aged management in two Appalachian woodlots

by Orris D. McCauley
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INTRODUCTION

THE FORESTRY PROFESSION holds many theoretical concepts about the economics of forest stand culture and development. However, the literature contains only a limited number of reports showing expected monetary outcomes over time that are based on actual measurements made of applied forest practices in natural hardwood stands. This is such a report.

In this paper we analyze the results of a forest-practices study made on two 31-acre forested areas on the Fernow Experimental Forest near Parsons, West Virginia. These two areas were selected for analysis because they were typical second-growth stands differing primarily in the stage of recovery from being cut and burned-over in earlier years. Further, they are among the few hardwood tracts where measurements for a silvicultural technique have been recorded for an extended period of time. These areas have been managed for 20 years by cutting practices based on individual-tree-selection silviculture. This paper shows, through economic analysis, how well the two tracts performed over the 20-year period.

THE TRACTS AND THEIR PAST TREATMENT

The two forest tracts are located at about 2,600 feet elevation where the average rainfall measures 59 inches annually. Soils are well drained, of medium texture, 3 to 4 feet deep. Both tracts were cut for sawlogs about 40 years before the individual-tree-selection cutting practices were tried. At that time, defective trees, below-sawlog-size stems, and unmerchantable species were left, so that in 1948 the stands were made up of two distinct groups of trees: the old growth left after the original logging, and the second growth that came in afterward.

The stands were typical of the better northern West Virginia Allegheny hardwood area and had a site index for oak of 75 feet at 50 years. Beech, red oak, yellow-poplar, black cherry, and sugar maple were dominant among the sawtimber-size trees.

Although the stands have historically undergone similar natural changes and losses and similar cutting practices, they differed widely in structure and stocking at initiation of management—probably because stand 1 suffered more from fire damage before the study was begun.

More complete accounts of the original conditions and past treatments of the forested areas have been published by Mitchell and Webster (*1961*) and Trimble (*1970*).

The first report was an economic analysis of the two tracts as small woodlots after 10 years of harvest cutting. The latter report was a 20-year analysis of uneven-aged silviculture and its effect on growth, yield, and species composition.

Both stands were cut *in* (but never cut over completely at one time) annually during the first 10 years of the cutting-practice study, and every 2 years during the latter 10 years. One-hundred-percent inventories were made in 1948, 1954, 1958, and 1968. All trees over 5.0 inches d.b.h. were tallied by 2-inch d.b.h. classes (table 1).

Table 1.—Stand physical statistics for the 20-year period of selection cutting

Characteristics	Initial inventory measurement, 1949	First re-inventory measurement, 1954	Second re-inventory measurement, 1958	Third re-inventory measurement, 1968
STAND 1				
Growing stock:				
Merchantable total ..... trees per acre....	192	183	180	166
Poletimber 6—10 inches ..... trees per acre....	160	149	142	115
Sawtimber 12+ inches ..... trees per acre....	32	34	38	51
Cull total ..... trees per acre....	8	1	4	1
Growing volume:				
Total merchantable ..... cubic feet per acre....	1,734	1,706	1,763	2,082
Poletimber 6—10 inches ..... cubic feet per acre....	853	809	796	679
Sawtimber 12+ inches ..... cubic feet per acre....	881	897	967	1,403
Total merchantable				
Poletimber 6—10 inches ..... cords per acre....	12.2	11.6	11.4	9.7
Sawtimber 12+ inches ..... board feet per acre....	4,611	4,605	4,882	7,296
Total cull per acre ..... cubic feet....	144	23	34	18
Cut volume/acre since inventory:				
Poletimber 6—10 inches ..... cords per acre....	—	1.3	.2	1.2
Sawtimber 12+ inches ..... board feet per acre....	—	1,143	862	424
Total ..... cubic feet per acre....	—	295	162	161
STAND 2				
Growing stock:				
Merchantable total ..... trees per acre....	143	140	138	142
Poletimber 6—10 inches ..... trees per acre....	100	93	91	91
Sawtimber 12+ inches ..... trees per acre....	43	47	47	51
Cull total ..... trees per acre....	10	0	4	2
Growing volume:				
Total merchantable ..... cubic feet per acre....	2,186	2,279	2,190	2,462
Poletimber 6—10 inches ..... cubic feet per acre....	569	527	501	489
Sawtimber 12+ inches ..... cubic feet per acre....	1,617	1,752	1,689	1,973
Total merchantable				
Poletimber 6—10 inches ..... cords per acre....	8.1	7.5	7.2	7.0
Sawtimber 12+ inches ..... board feet per acre....	9,227	9,968	9,502	11,274
Total cull per acre ..... cubic feet....	257	0	42	19
Cut volume/acre since inventory:				
Poletimber 6—10 inches ..... cords per acre....	—	.8	.3	.4
Sawtimber 12+ inches ..... board feet per acre....	—	1,728	2,019	1,420
Total ..... cubic feet per acre....	—	341	348	269

EVALUATION RESULTS

The methods used in the economic analysis were built on data developed by Trimble (1970) in his silvicultural analysis of the stands. We had to place a value on the original stands and subsequent inventories and measure the value of the timber harvested since the study began. To do this, we grouped the timber species growing on the study areas into pricing groups by tree grades. The tree grades were based on a previously established relationship to butt-log grades and log height.

The prices shown, except for minor exceptions, are those developed by the USDA Forest Service for stumpage appraisal by butt-log tree grades on the adjacent Monongahela National Forest (table 2). The prices are net sums developed from a careful analysis of grade-lumber recovery values by butt-log tree grades, less total lumber-conversion costs. For low tree grades, tree-conversion costs can exceed tree value and result in negative stumpage values. To avoid negative values in the analysis, all negative stumpage-appraisal prices were assigned positive $1.00 per thousand board foot values. For this reason, all merchantable trees below butt-log grade 3

Table 2.—Stumpage prices used for stand economic evaluation

[In dollars]

Species group number	Species included in group	Per thousand board feet				
		Trees with butt-log grade 1	Trees with butt-log grade 2	Trees with butt-log grade 3	Trees with lower butt-log grades	Pulpwood, cords
1	Pulpwood[1]	—	—	—	—	0.50
2	Sawtimber spp.[2]	6	6	6	1	.50
3	White oak	57	16	1	1	.50
4	Red oak	69	34	12	1	.50
5	Yellow-poplar[3]	58	32	16	1	.50
6	Black cherry	121	75	35	1	.50
7	Sugar maple	87	42	9	1	.50
8	Red maple	72	32	2	1	.50
9	Sweet birch	91	34	1	1	.50
10	Basswood	69	39	17	1	.50
11	White ash	118	56	21	1	.50

[1] Includes American hornbeam, eastern hophornbeam, Fraser magnolia, sassafras, downy serviceberry, pin cherry, black locust, striped maple, flowering dogwood, sourwood, and other species.

[2] Includes hemlock, bigtooth aspen, bitternut hickory, shagbark hickory, American beech, chestnut oak, American elm, slippery elm, rock elm, black gum, and butternut.

[3] Includes cucumbertree.

were arbitrarily grouped and assigned a value of $1.00 per thousand board feet.

To establish values for those merchantable trees below sawlog size, we appraised all trees smaller than the 12-inch d.b.h. class as pulpwood. The stumpage values shown were then used to evaluate all material harvested.

The values for the analysis and evaluation were derived by applying butt-log grade and price information (table 2) to volume of the original and subsequent inventories and to volumes of the timber removed at each harvest.

Costs of 1 cent per diameter inch were used to determine the cost of cull removal. These costs were deducted from the returns as they were incurred.

The per-acre values shown are yearly net summations of inventory value increases, harvest incomes, and cull removal costs.

Many of the harvest cuts would be classed as uneconomic because of the small volumes and values removed during some years. However, we do not believe this procedure invalidates any of our assumptions, because the cuts could have been combined and made at longer intervals. After all, the annual (first 10 years) and the biennial (second 10 years) cuts were rotated about the woodlots so that, in effect, a 10-year cutting cycle was used.

All stumpage prices and costs used in the evaluation were maintained at a constant level. The authors recognize that the values of the harvested products and costs of services have changed since the institution of this study. However, a single price is used to avoid changing money values due to inflation. Thus, value change can be measured without the effects of a change in the purchasing power of the dollar.

Implicit in our assumption is that all products would sell in the market at the quoted prices.

Because forest-owner goals vary so widely, we made no attempt here to determine the advantage of investing in uneven-aged forest improvement-cutting practices. Our primary concern was to show how the two stands responded physically to the cutting practice and performed economically for the 20 years. What might be a satisfactory performance and an attractive investment for one forest owner, and with a particular set of management goals and problems, might not be attractive to another.

We should make it clear at this time that the analyses made here apply only to the 20-year development period of stand management. We do not know how these stands will perform physically or economically in the

future as they approach closer to equilibrium with the prescribed sivilcultural system (described in detail by *Trimble 1970*).

To meet the needs and interests of a wide range of ownership situations, five types of evaluations were made:

1. Stand valuation changes from timber growth and stumpage sales.
2. Internal rate of return on investment.
3. Net present worth.
4. Net future worth.
5. Forestry as an investment.

Stand Valuation Changes from Timber Growth and Stumpage Sales

Before a forest owner invests his time and money in a cutting practice to improve his forest, he needs information about the expected economic performance of forest stands subjected to that cutting practice. Our analysis provides case examples of the 20-year performance of a stand on which individual-

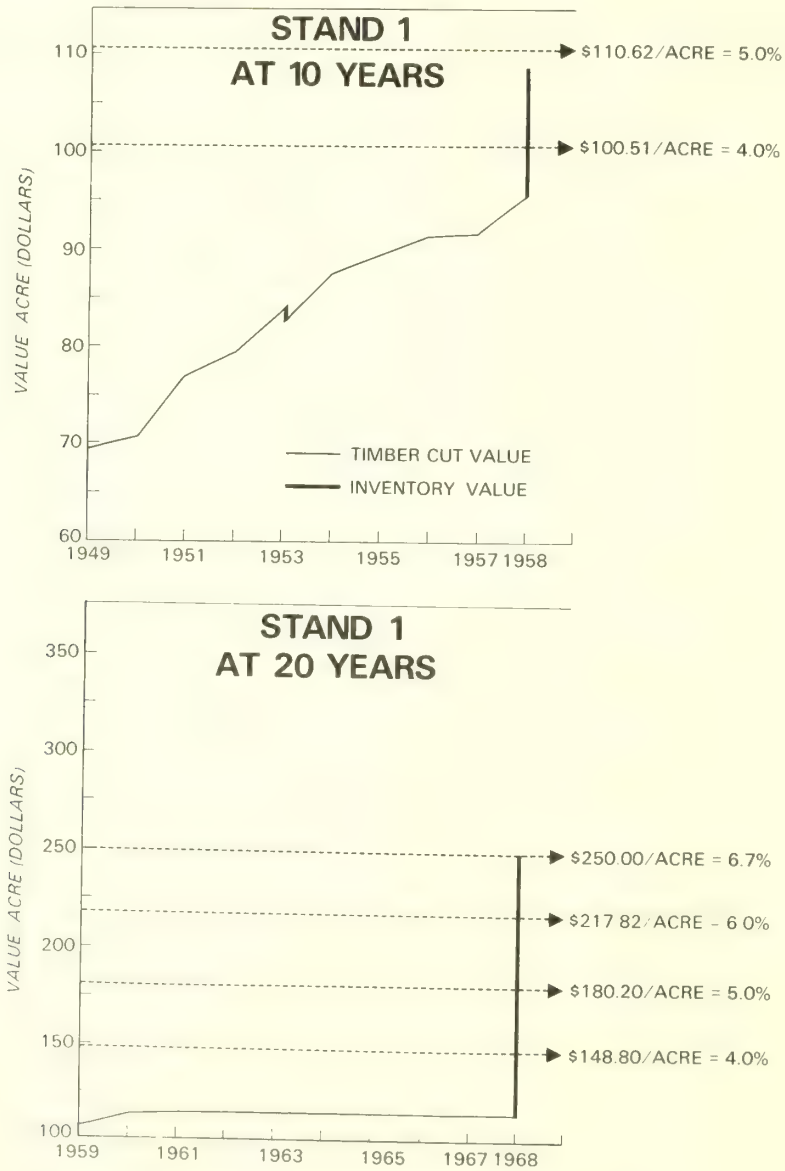
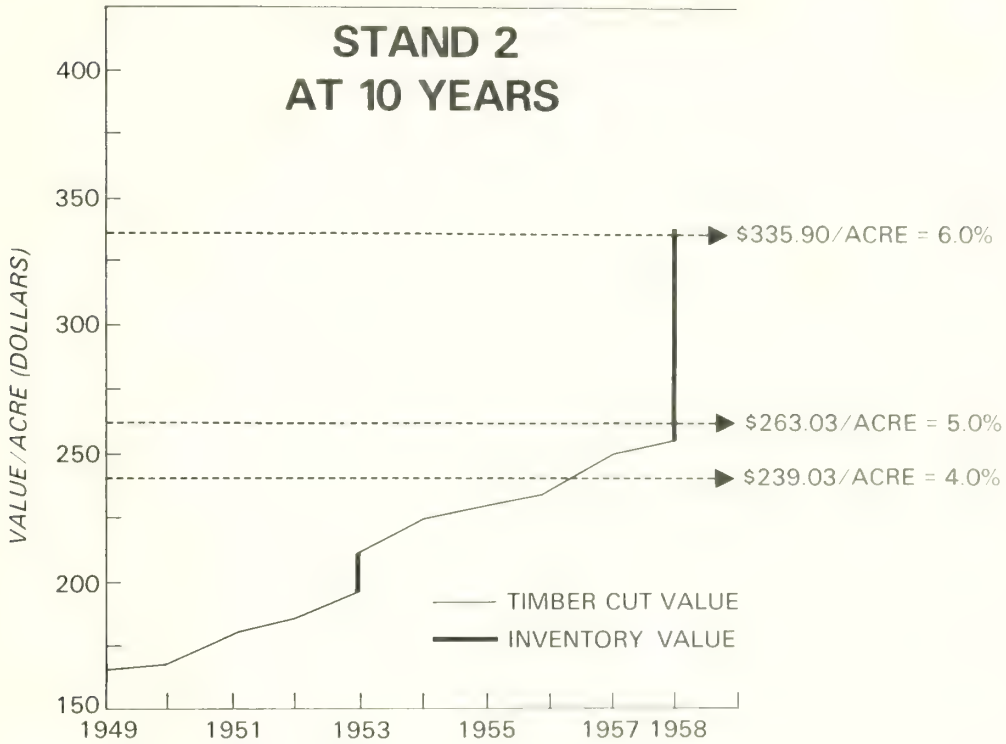


Figure 1.—Stand I values and performance.



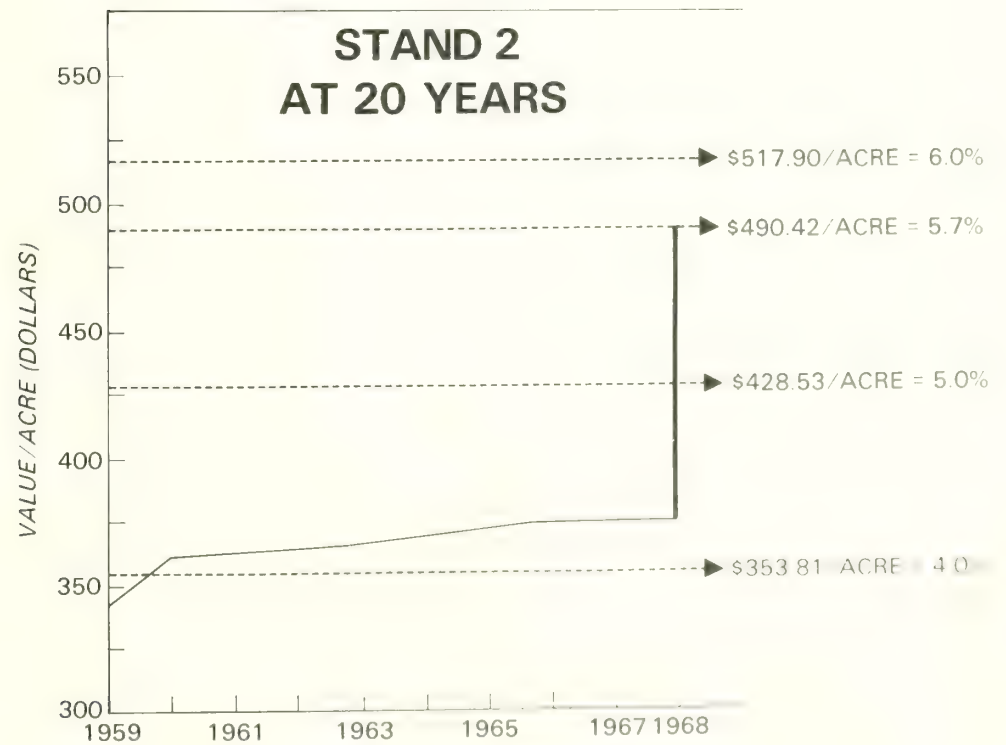


Figure 2.—Stand 2 values and performance.

tree-selection cutting practices have been applied.

The results shown are for the first and second 10-year periods for stands 1 and 2 (figs. 1 and 2). These diagrams show the annual net value increment per acre and the rate of value increase. For example, the initial value of stand 1 was $68 per acre in 1949. Adding in the annual cutting value and ingrowth value increment for the next 10 years increased the stand value to $108 per acre in 1958. In the same way, stand 1 further increased in value to $250 per acre in 1968.

Stand 1 exhibits a higher rate of return for the 20-year period than stand 2, with earnings above 6 percent. Stand 2 shows an opposite trend for the period, earning at a rate of 6 percent for the first 10 years but at a slightly lower rate for the 20-year period. Stated in another way: the rate of value increase is greater for stand 1 in the last 10-year period, even though the per-acre value of stand 2 is more than double that of stand 1.

Internal Rate of Return on Investment

The internal rate of return is that compounded interest rate that equates the present value of a series of costs and incomes to zero—zero net present worth. It is a frequently used measure of the effectiveness of an investment similar to our woodlot investment. If the net income of a stand is increasing quickly, we would expect to find a correspondingly high internal rate of return. For example, stand 1 had its highest internal rate of return—11.2 percent—during the second 10-year period, whereas stand 2 had a higher internal rate of return in the second 5-year period—12.3 percent (table 3). Although stand 2 had a higher per-acre value than stand 1—$490 vs. $250—it also, therefore, represented a greater initial investment. Thus we find that stand 1 had a higher internal rate of return for the 20-year period—8.0 to 7.2 percent.

Net Present Worth

The net present worth of a forest stand is a discounted residual stand value, determined by subtracting the beginning value of a stand investment from the future value of the stand (actual or expected), discounted to the present. In our case, we have actual future value —at the end of the 20-year period.

The net present worth (profit or the residual in our example) is a measure of the effectiveness of forest management and can serve as a basis for decision-making. The greater the rate of interest desired on the investment, the smaller the net present worth and profit to the forest owner at the end of the investment period.

In this case-history study, we show net present worth for a range of interest rates (table 4).

To illustrate what the data show, let's take the situation where for some reason an owner does not demand a high interest return on a forestry investment. As an extreme example, what would be the net present worth of stand 1 if 0 percent interest rate would satisfy the owner? The net present worth per acre, or the profit, would be the difference between the initial value of $68 and the 20-year value of $250, or $182 per acre (table 4).

If, on the other hand, the owner required 4 percent interest on his invested capital, the $250 stand value after 20 years would have a net present worth of $46 per acre. If the owner demanded a 6.7 percent interest rate, the net present worth per acre would be approximately $0, since the discounted value of the

Table 3.—Comparison of internal rate of return for the two stands

Stand	First 5 years, 1949-53	Second 5 years, 1954-58	First 10 years, 1949-58	Second 10 years, 1959-68	20 years, 1949-68
1	4.3	7.2	5.6	11.2	8.0
2	5.9	12.3	8.7	5.3	7.2

Table 4.—Investment in stand: net present worth or profit on investment[1]

[In dollars]

Acceptable rate discount (percent)	Stand value/acre, 1948	Stand[2] value/acre, 1968	Discounted value of 1968 stand in 1948 at indicated rate	Net present worth or profit/acre
		STAND 1		
0	68	250	250	182
2	68	250	168	100
3	68	250	139	71
4	68	250	114	46
5	68	250	94	26
6	68	250	78	10
6.7	68	250	68	0
8	68	250	54	−14
10	68	250	37	−31
		STAND 2		
0	161	490	490	329
2	161	490	330	169
3	161	490	272	110
4	161	490	224	62
5	161	490	185	23
5.7	161	490	162	1
6	161	490	153	−9
8	161	490	105	−56
10	161	490	73	−89

[1] Based on acceptable interest rates at the beginning of the improvement practice.
[2] Stand value does not include earnings from reinvested capital.

1968 stand—$250—would be equal to the actual 1948 value or $68.

Net Future Value

Another economic measure of the effectiveness of management in a forest stand is *net future value*. Here again, this is a measure whose magnitude is related to the interest rate the owner chooses. To compute net future stand value for any given interest rate, subtract: (1) the required end-of-period stand value (required to earn the stated interest rate on initial stand value) from (2) the actual end-of-period stand values (table 5).

The required end-of-period stand value is determined by carrying all costs at the stated interest rate and discounting all income at the same rate. In other words, we can compute the required stand value to the end of the period specified once we have established the interest rate, the cash value of the initial stand, and the subsequent cash flows from such items as timber harvested, cost of timber-stand improvement, stand volume, and quality changes. In our forest stands, the following operations generated cash flows and resulted in net changes in stand cash value: 16 cuttings and 4 inventories. Time period for the evaluation of the initial stands was 20 years. All subsequent cash flows would have a shorter compounding time period.

The net future values generated by stands 1 and 2 have been computed for various rates of interest (table 5). For example, if an owner would accept 0 percent interest for stand 1 (table 5) on an initial investment of $68 per acre, and the stand was still worth that value 20 years later, (its actual value is $250 per acre) then he would expect the net future value (or profit) to be $182 per acre. If the owner would accept no less than 8 percent

Table 5.—Stand performance based on net future value and owner's desired rate of interest on investment

[In dollars]

Rate of interest (percent)	Beginning or initial investment/acre, 1948	Required value in 1968/acre for stand to earn indicated interest rate	20-year results: profit or loss/acre[1] (net future value)
		STAND 1	
0	68	68	182
2	68	101	149
3	68	123	128
4	68	149	101
6	68	218	32
8	68	317	−66
10	68	457	−207
		STAND 2	
0	161	161	335
2	161	240	250
3	161	292	199
4	161	354	137
5.7	161	489	1
6	161	518	−27
8	161	753	−262
10	161	1,750	−1,259

[1] These figures are the difference between the actual stand values in 1968 ($250 for stand 1, $490 for stand 2) and the required stand value in 1968.

return on investment capital, then stand 1 would not make it. The net future value would be a minus $66 per acre at the end of 20 years.

Forestry as an Investment

Many forest owners and individuals interested in forestry like to see economic information expressed in terms so that a timber investment can be compared with some alternative investment. Most of these owners like to see the expected returns from a forestry enterprise under various cost combinations. We made computations from the records for these two stands showing what interest rates would be earned for different (1) land, (2) management-tax, and (3) timber-holding costs. We use the term "management-tax" to express the combined costs of providing the management services of a forester or manager and the annual tax assessment on a timber tract. Management services include making a simple management plan, marking trees for cutting, planning road layout and sale administration—all pro-rated on an annual basis. The values used were realistic for the area in 1949.

The values used in these computations are those generated from timber production alone. Other values and benefits such as wildlife, water, property, and recreation-aesthetic attraction are not included in this investment evaluation.

Investment in timber and land.—Some owners might be interested in an investment where land and timber-holding costs are the only costs to be considered in the investment (table 6).

For stand 1, a 2-percent interest rate could be earned on base land values up to $100 per acre; and 5-percent interest could be earned on base land values through $25 per acre. And if land costs were less than $15 an acre, stand 1 would have produced a 6-percent interest return.

As an example for stand 2, if a man bought land at $50 per acre (and the timber value was $161 per acre, as it was 20 years ago), then, based on the performance of this stand under selection cutting, he could expect to earn about 4 percent on his investment over a

Table 6.—Investment in stand: possible returns after 20 years of uneven-aged cutting at indicated land and timber investment

[In dollars]

Investment/acre			Stand value/acre necessary to earn the indicated interest rate after 20 years[2]				
Initial land cost	Initial timber value	20-year[1] total	2%	3%	4%	5%	6%
			STAND 1				
10	68	78	116	141	171	207	250
15	68	83	123	150	182	220	266
25	68	93	138	168	204	246	298
35	68	103	153	186	225	273	330
50	68	118	175	213	258	313	378
75	68	143	212	258	313	379	458
100	68	168	250	303	368	446	539
			STAND 2				
10	161	171	255	310	376	455	550
15	161	176	262	319	387	468	566
25	161	186	277	337	409	495	598
35	161	196	292	355	431	521	630
50	161	211	314	382	463	561	678
75	161	236	351	427	518	627	758
100	161	261	389	472	573	694	839

[1] Includes initial timber investment plus initial land costs carried at interest to end of the period.

[2] Values and connected interest rates to the right of the heavy lines are unattainable because the maximum value/acre generated after 20 years was $250 for stand 1, $490 for stand 2.

20-year period. A buyer of stand 2 could not expect to earn over 5 percent unless he could buy land for less than $10 per acre.

Investment including timber and management-tax costs only.—For some owners, land cost is not an investment consideration to be charged against timber production. They recognize land costs as real, but consider them chargeable to some other function such as production of water or wildlife, a hedge against a future timber supply, or perhaps aesthetic and recreational values.

For this type of owner, we show only the cost of holding the timber inventory and management-tax charges for maintaining the stand (table 7).

The potential for producing investment income under the costs used is affected little by the inclusion or exclusion of land costs as a cost chargeable to timber production.

We show that forest cutting practice investments that include only timber and management-tax costs could earn as high as 5-percent return annually on the investment capital in stand 1 or 2. As an example, a forest owner could earn 5-percent interest in stand 1 if management-tax assessment does not exceed $2.00 per acre; the investment management-tax charges could not exceed $3.00 per acre annually for him to earn a 4-percent return. If we are looking for higher returns, stand 1 would have to be valued at $347 per acre to earn 6 percent with management-tax costs at $3.50 per acre. These values, although unattainable, illustrate how much higher timber values must be if increasing management-tax costs are to be covered by the increased value of the timber stand.

Investment including management-tax, land, and timber.—The conventional way of looking at an investment in forest practices is that timber returns alone must pay for management of the forest tract, pay the taxes, and absorb the cost of financing the stored timber values. If we accept this viewpoint of a forest investment, we ignore any of the other values

Table 7.—Investment in stand: possible returns after 20 years of uneven-aged cutting at indicated management-tax and timber-investment costs

[In dollars]

Investment/acre			Stand value/acre necessary to earn indicated interest rate after 20 years[2]				
Annual management-tax cost	Initial timber value	20-year[1] total	2%	3%	4%	5%	6%
			STAND 1				
1.00	68	88	125	150	179	213	255
1.50	68	98	137	163	193	230	273
2.00	68	108	150	176	208	246	291
2.50	68	118	162	190	223	263	310
3.00	68	128	174	203	238	279	328
3.50	68	138	186	217	253	296	347
			STAND 2				
1.00	161	181	264	319	384	462	555
1.50	161	191	276	332	398	478	573
2.00	161	201	289	345	413	495	591
2.50	161	211	301	359	428	511	610
3.00	161	221	313	372	443	528	628
3.50	161	231	325	386	458	544	647

[1] Includes initial timber investment plus annual costs carried at interest to end of the period.

[2] Values and connected interest rates to the right of the heavy lines are unattainable because the maximum value/acre generated after 20 years was $250 for stand 1, $490 for stand 2.

Table 8.—Investment in stand: possible returns after 20 years of uneven-aged cutting at indicated management-tax, land, and timber-investment costs

[In dollars]

Investment/acre				Stand value/acre necessary to earn indicated interest rate after 20 years[2]				
Annual management-tax cost	Initial land cost	Initial timber value	20-year[1] total	2%	3%	4%	5%	6%
			STAND 1					
1.00	10	68	98	140	168	201	240	287
1.00	15	68	103	148	177	211	253	303
1.50	25	68	123	175	208	248	296	353
2.00	35	68	143	202	240	285	339	404
2.50	50	68	168	236	280	333	396	470
3.00	75	68	203	285	339	402	478	569
3.50	100	68	238	336	397	472	561	667
			STAND 2					
1.00	10	161	191	279	337	405	488	587
1.00	15	161	196	287	346	416	501	603
1.50	25	161	216	314	377	453	544	653
2.00	35	161	236	341	409	490	587	704
2.50	50	161	261	375	449	538	644	770
3.00	75	161	296	424	508	607	727	869
3.50	100	161	331	474	566	677	810	967

[1] Includes initial land and timber investment plus annual costs carried at interest to the end of period.

[2] Values and connected interest rates to the right of the heavy lines are unattainable because the maximum value/acre generated after 20 years was $250 for stand 1, $490 for stand 2.

and benefits derived and attributable to the forest property such as wildlife, water, aesthetics, and recreation. For those individuals looking at forestry as a timber investment of this type, we have made an appropriate investment analysis (table 8).

These results show that an investment in forest practices under these conditions will return as high as 5 percent in stand 1 if management-tax costs do not exceed $1.00 per acre and land costs do not exceed $10. In stand 2, under the same conditions, these costs also could not exceed $1 and $10 to earn a 5-percent return.

DISCUSSION AND CONCLUSIONS

The records of these two 31-acre tracts over the past 20 years have provided the necessary physical information for an economic evaluation of a timber stand where individual-tree-selection cutting practices were applied.

In this paper, we have converted physical data into useful economic indicators by several methods. The economic performance of these tracts provides an indication of the returns an investor might expect during a 20-year development period by the application of similar practices to comparable areas. Although the sample tracts are small, the authors feel that they are large enough to indicate that the results are applicable to larger forest areas under similar cutting practices and stand conditions.

Although none of the methods of economic appraisal are new, they provide forest owners with a basis for decision-making other than the usual physical relationships.

The economic "goodness" or "badness" of an investment in forestry depends on the objectives of the investor. Because this difference in the objectives exists, we approached the matter of economic evaluation in a number of different ways with the hope that most investors would be able to choose an approach that fits their economic situation.

Certain types of large forest owners, such as corporations or public agencies, might utilize the internal rate of return as a timber-stand evaluation measure. Where there are initial costs or a series of costs in a timber investment, the internal rate of return provides a means of measuring the subsequent returns on the investment.

Determining present net worth and net future value are commonly-used methods for evaluating business investments. In the former, we determine the value now of some value that will occur in the future, using interest as an investment cost. In the latter, we determine the future value of an investment made today. Again, interest is used as a cost of investment.

In the tables we have shown a series of interest rates to illustrate where zero benefits are produced by the timber investment. In some situations a 0 percent interest might be an acceptable rate. A forest owner, such as a pulp industry, might charge 0 percent interest if their investment in forest land is used to insure a continuous supply of wood. Other types of owners might derive multiple benefits from forest land and would charge a low interest rate against timber production alone.

We have shown in our analysis how varying management costs can affect the expected returns on a business investment in timber. The resultant interest rate measures how varying costs, including the cost of holding stored values in timber, affect expected investment returns over time.

Timely inventory and other physical measures can provide useful information for managing volume growth and yield of timber stands in the forest business. These measures are the first step to management. The second measure, economic evaluation, provides the basis for operating the forest as a business.

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APPENDIX

List of common and scientific names of species referred to in this study.

Ash, white	*Fraxinus americana* L.
Aspen, bigtooth	*Populus grandidentata* Michx.
Basswood	*Tilia americana* L.
Beech, American	*Fagus grandifolia* Ehrh.
Birch, sweet	*Betula lenta* L.
Butternut	*Juglans cinerea* L.
Cherry, black	*Prunus serotina* Ehrh.
Cherry, pin	*Prunus pensylvanica* L. f.
Cucumbertree	*Magnolia acuminata* L.
Dogwood, flowering	*Cornus florida* L.
Elm, American	*Ulmus americana* L.
Elm, rock	*Ulmus thomasii* Sarg.
Elm, slippery	*Ulmus rubra* Muhl.
Gum, black	*Nyssa sylvatica* Marsh.
Hemlock, eastern	*Tsuga canadensis* (L.) Carr.
Hickory, bitternut	*Carya cordiformis* (Wangenh.) K. Koch
Hickory, shagbark	*Carya ovata* (Mill.) K. Koch
Hophornbeam, eastern	*Ostrya virginiana* (Mill.) K. Koch
Hornbeam, American	*Carpinus caroliniana* Walt.
Locust, black	*Robinia pseudoacacia* L.
Magnolia, Fraser	*Magnolia fraseri* Walt.
Maple, red	*Acer rubrum* L.
Maple, striped	*Acer pensylvanicum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, chestnut	*Quercus prinus* L.
Oak, northern red	*Quercus rubra* L.
Oak, white	*Quercus alba* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Serviceberry, downy	*Amelanchier arborea* (Michx. f.) Fern.
Sourwood	*Oxydendrum arboreum* (L.) DC.
Yellow-poplar	*Liriodendron tulipifera* L.

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Investment in PRECOMMERCIAL THINNING of NORTHERN HARDWOODS

by Orris D. McCauley
and David A. Marquis

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Investment in PRECOMMERCIAL THINNING of NORTHERN HARDWOODS

INTRODUCTION

PRECOMMERCIAL THINNING in young northern hardwood stands can increase value yields by concentrating growth on the more valuable trees. But is the increased value yield large enough to offset the compounded costs of the thinnings?

The answer to this question depends upon the product goals, the investment return desired, and the time periods under consideration. The solution to the question appears simple, but becomes complex when we consider the objectives of the forest owner in terms of product, investment return, time period, and the owner's objective in the land investment itself.

Because of this complexity, the analyses reported in this paper are limited to the defined and specified goals. Essentially, the procedures for finding answers to different objectives or goals than those specified in this report will remain the same. The primary purpose of this report is to show how biological data can be used to provide useful economic information.

METHODS

Data used in these economic evaluations came from a study of precommercial thinning in a 25-year-old northern hardwood stand in New Hampshire. Stand composition and size distribution before thinning are shown in table 7, (appendix). Of approximately 400 crop trees selected per acre in this stand, about half were paper birch; the other half were yellow birch, white ash, sugar maple, red maple, or beech (table 8, appendix).

Other reports have been made on the biological aspects of this study since its initiation in 1959. The stand history and condition at the time of thinning have been described in detail (*Marquis 1967*). The effects of thinning on growth and quality of the residual stems,

as well as further details of how the thinnings were analyzed, have been reported elsewhere (*Marquis 1969*). This report has incorporated the necessary physical data from those earlier studies.

The thinning study involved three thinning techniques based on crown competition for growing space, plus a control. Treatments were applied on 1/4-acre plots, and each was replicated 5 times for a total of 20 plots. The treatments were as follows:

1. No thinning.—These plots were left undisturbed to develop naturally. They constituted a control or standard against which to measure the response of other groups of plots.

2. Light thinning.—For each crop tree, the one nearby tree offering the greatest competition was removed.

3. Species thinning.—Aspen, pin cherry, and striped maple were eliminated, and red maple sprout clumps of three or more stems were thinned. The relationship of thinned trees to crop trees was not considered.

4. Heavy thinning.—All trees competing directly with the crop trees were removed.

The thinning study provided a record of species and sizes of trees present before thinning, those removed in thinning, and those present 5 years after thinning in 1964 when the stand was 30 years old. Growth data from selected individual crop trees of all sizes and species were also obtained from the thinning study (table 9, appendix). From the 1964 growth, mortality, and stand-table records, stand-table projections were made for each plot to: (1) 10 years after thinning or a stand age of 35 years; (2) 15 years after thinning or a stand age of 40 years; (3) 20 years after thinning or a stand age of 45 years. These projections were then used as a basis for a series of tests to determine which thinning treatment—species, light, heavy or control—performed better under varying product and investment return goals.

Stand Projections

The stand-table projections were made by using tree-diameter-movement ratios developed from the growth data, using the method described by Davis (*1954*). After projection, estimated mortality was deducted to produce the final stand tables for 10, 15, and 20 years after thinning. Mortality was not considered in the crop-tree stand projections.

Timber volumes, measured in cords, were estimated by multiplying numbers of trees shown in the stand tables by appropriate volumes. Local volume tables were constructed by applying height-diameter relationships for trees on the Bartlett Experimental Forest in New Hampshire (where the thinning-study plots were located) to the standard Gevorkiantz and Olsen volume tables for hardwoods, to a 4-inch top inside bark (*1955*). Conversions were also made to reflect volumes to a 6-inch top for estimating outcomes for higher-grade products such as boltwood. The final product of the projections was the volume of each plot by species and size class, in cords to a 4-inch top and to a 6-inch top as summarized in tables 10 and 11 (appendix).

To make the stand projections, it was necessary to assume that:

1. All trees would maintain the same growth rate during the three subsequent 5-year projection periods as they actually achieved during the first 5-year study period. For example, 6-inch paper birch trees in the heavy-thinning plots grew an average of 1.13 inches in the first 5-year study period, so we projected the same growth rate for the next three 5-year periods for these trees.

2. Mortality by treatment and species would continue at the same relative rate as during the first 5-year period; it would occur in the smallest size classes first; and no mortality would occur after the trees had reached 6 inches d.b.h.

Neither of these assumptions is entirely valid. Both growth rate and mortality can be expected to change as the stands close and the initial effects of the thinning disappear. To guard against the introduction of large errors,

we tested our projection procedures by projecting the original (1959) stand tables for 5 years and comparing the results with the actual 1964 stand tables. Projections made for the other three 5-year periods were also compared with published yield tables for northern hardwood stands of these ages (*Leak, Solomon, and Filip 1969*). Since the projected yields conformed reasonably well to the published yield tables, and since the differences of yield among the various thinning practices were logical, the projected stand tables were judged satisfactory for our purposes.

Economic Evaluation

Cost and value of the precommercial thinnings were made by using the most reliable cost estimates available. Cost for removal of precommercially thinned trees are not well established, but were estimated at 1 cent per diameter inch for the trees removed. For most of this evaluation we did not include the cost of marking timber, land, taxes, or supervisory management. Although the latter three costs are constant for any thinning method, we have used the costs shown in table 1 for this analysis.

Product values were estimated from specifications and price quotations of several wood-products manufacturers. The following schedule of prices and specifications was adopted:

Product	*Specifications*	*Unit stumpage price (per cord)*
Pulpwood	All merchantable species; volume measured to 4-inch top.	$ 2.00
Small boltwood	Paper birch, yellow birch, and white ash trees only; volume measured to 6-inch top.	$ 8.00
Large boltwood	Not calculated unless stand contained at least 20 paper birch, yellow birch, or white ash trees per acre 12-inches d.b.h. and larger; volume measured to 6-inch top.	$14.00

Using the stand volume projections and cost and product price estimates described above, we calculated the value attained by each of the plots after 5, 10, 15, and 20 years. These values were calculated for several products or product combinations as follows:

1. *Pulpwood.*—Value of all trees to a 4-inch merchantable top height, including non-crop trees.
2. *Small boltwood.*—Value of birch and ash trees 6-inches d.b.h. or larger to a 6-inch merchantable top height.
3. *Large boltwood.*—Value of birch and ash trees 6-inches d.b.h. or larger; minimum requirement at least 20 trees 12 inches d.b.h. or larger/acre.
4. *Combined pulpwood-boltwood.*—
   a. *Small boltwood-pulpwood.*—All merchantable trees evaluated; values included small boltwood plus pulpwood value of all other trees.
   b. *Large boltwood-pulpwood.*—All merchantable trees evaluated; values included large boltwood plus pulpwood value of all other trees.

To test the performance of the thinning methods, the five values for each thinning-practice plot were then compared with similar values for the unthinned plots for a total of 25 comparisons between a thinned and unthinned treatment to see how much the thinning had increased the stand value. All com-

Table 1.—Cost estimates used in the economic evaluation

Thinning method	Average cost/acre for tree removal	Initial timber land costs/acre	Annual tax costs/acre	Marking costs/acre	Annual supervision and protection costs/acre
No thinning	—	$20.00	$0.25	—	$0.25
Species thinning	$17.84	20.00	.25	—	.25
Light thinning	10.90	20.00	.25	$3.00	.25
Heavy thinning	19.76	20.00	.25	3.00	.25

parisons showing positive value differences were then divided by tree-removal costs to determine the value ratio between a thinned plot and each unthinned plot. Each ratio was then used to determine the rate of return.

Rate of return = $(1 + i)^n = \frac{V_n}{V_o}$, where i = interest rate; n = period of years; V_n = net income due to thinning after n years; and V_o = present capital value of investment (cost of thinning).

In addition to the individual plot values, we calculated the average treatment volume (in cords per acre) and value for each age-product situation for the *crop trees only* and the volume and value for each age-product situation for the total stand (tables 2 and 3).

RESULTS AND DISCUSSION

Thinning Investment Under Limited Costs

We first considered an investment in thinning where a forest owner considered the cost of thinning only. Table 4 shows the proportion of the thinning investment comparisons that equal or exceed 0, 2, 4, 6, and 10 percent return on thinning investment. For example, the 96 percent at the right hand side of the first row of table 4 means that species thinning produced a positive return from thinning at age 45 in 96 percent (24 of 25) of the comparisons, under a combination pulpwood-bolt-

Table 2.—Average volume and value in standard cords/acre generated by selected product and time period for crop trees only

Thinning method	Small boltwood @ $8/cord								Large boltwood @ $14/cord	
	Age 30		Age 35		Age 40		Age 45		Age 45	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
	Cords		*Cords*		*Cords*		*Cords*		*Cords*	
No thinning	[1]	[1]	[1]	[1]	6.9	$55	10.0	$80	[1, 2]	[1, 2]
Species thinning	[1]	[1]	6.4	$51	10.1	81	14.7	117	14.7	$206
Light thinning	[1]	[1]	6.4	51	9.7	78	13.6	109	13.5	190
Heavy thinning	[1]	[1]	5.3	42	8.9	71	13.2	106	[1, 2]	[1, 2]

[1] Insufficient volume to meet the specification for products.
[2] Maximum volume and value would equal that shown for small boltwood and pulpwood at age 45. See specifications.

Table 3.—Average volume and value in standard cords/acre generated by selected product and time period for the total stand

Thinning method	Pulpwood		Small boltwood and pulpwood @ $8/cord & $2/cord				Large boltwood and pulpwood @ $14/cord & $2/cord	
	Age 45		Age 40		Age 45		Age 45	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value
	Cords		*Cords*		*Cords*		*Cords*	
No thinning	24.5	$49	17.1	$87	24.5	$124	[1]	[1]
Species thinning	27.0	54	18.1	107	27.0	157	27.0	$260
Light thinning	25.6	51	18.2	97	25.6	134	25.6	216
Heavy thinning	24.9	50	15.8	86	24.9	131	[1]	[1]

[1] Insufficient volume to meet the specification for large boltwood; maximum volume and value would equal that shown for small boltwood and pulpwood at age 45. See specifications.

Table 4.—Rate of return from investment in precommercial thinning: proportion of comparisons meeting selected rates of return in various potential markets

Treatments compared	Pulpwood @ $2/cord	Boltwood					Combination of pulpwood @ $2/cord and boltwood @ $8/cord		Combination of pulpwood @ $2/cord, small boltwood @ $8/cord, and large boltwood @ $14/cord
		Small @ $8/cord				Large @ $14/cord			
	Age 45	Age 30	Age 35	Age 40	Age 45	Age 45	Age 40	Age 45	Age 45
					0 PERCENT OR MORE RATE OF RETURN				
Species vs. no thinning	96	0	76	76	80	80	80	80	96
Heavy vs. no thinning	100	0	36	68	76	40	68	92	88
Light vs. no thinning	80	0	60	80	80	76	80	80	92
					2 PERCENT OR MORE RATE OF RETURN				
Species vs. no thinning	20	0	64	56	64	76	56	64	76
Heavy vs. no thinning	0	0	32	44	52	40	44	56	76
Light vs. no thinning	48	0	52	60	64	76	60	64	88
					4 PERCENT OR MORE RATE OF RETURN				
Species vs. no thinning	0	0	64	52	56	76	52	56	76
Heavy vs. no thinning	0	0	32	32	32	40	28	44	64
Light vs. no thinning	8	0	48	60	60	76	60	60	80
					6 PERCENT OR MORE RATE OF RETURN				
Species vs. no thinning	0	0	64	44	40	72	44	36	76
Heavy vs. no thinning	0	0	32	16	12	40	12	12	44
Light vs. no thinning	0	0	48	56	48	76	56	48	80
					10 PERCENT OR MORE RATE OF RETURN				
Species vs. no thinning	0	0	48	12	4	64	12	4	64
Heavy vs. no thinning	0	0	32	8	0	32	4	0	32
Light vs. no thinning	0	0	48	20	8	64	20	8	52

wood market situation. The 76 percent in the next group below indicates that species thinning yielded at least 2 percent return on investment in 76 percent of the comparisons.

The study results revealed several general trends. First, returns from precommercial thinnings are low during the first 5 to 10 years after thinning. Higher returns are not obtained for at least 15 to 20 years. Second, returns from thinning are low if low-value products such as pulpwood are the goal. Much higher returns are realized when high-value products such as boltwood are to be obtained.

Thus, investments in precommercial thinning are most likely to be justified when high-value products are the goal and where short rotations or early returns are not required. This makes sense, for precommercial thinning has relatively little effect on total stand growth; it serves merely to distribute growth to the crop trees, which have high market value.

Another general conclusion may be drawn from table 4: that fairly attractive returns may be expected from precommercial thinnings where high-value boltwood products are the management goal. For example, after 20 years the more successful thinning techniques had produced 6 percent or more return on investment in 75 to 80 percent of the comparisons, and they had produced 10 percent return on investment in 50 to 65 percent of the comparisons analyzed. Although currently-available data did not justify analysis beyond a 20-year time span, it seems possible that analyses performed at the end of the rotation (normally 60 to 100 years for these species) would reveal even more attractive returns when sawtimber and veneer would be obtained.

Thinning Investment For Various Owners

The 0-, 2-, and 4-percent interest rates shown in table 4 apply to land on which the owner would continue to hold the land even if he could not realize a profit from timber-growing activites alone. This situation is common among public land owners and some private owners who hold their land for multiple benefits such as wildlife, water, and recreation. It might also apply to those who hold forest land to insure a steady or guaranteed source of wood for their own mills. Generally, the fixed costs of taxes, protection, and land management do not influence decision-making on these lands.

Table 5.—Expected gross per-acre income from growing northern hardwood timber to age 45, with and without thinning on land owned for multiple-benefits

Item	No thinning	Species thinning	Light thinning	Heavy thinning
1. Average merchantable volume in standard cords/acre[1]	24.5	27.0	25.6	24.9
2. Highest merchantable value from harvesting both pulpwood and boltwood in 20-year period	$124	$260	$216	$131
3. Present value of wood attributable to thinning (item 2 minus $124)	0	136	92	7
4. Marking and tree-removal cost[2]	0	17.84	13.90	22.76
5. Investment cost for marking and tree removal after 20 years @ 6-percent compound interest rate	0	57	45	73
6. Percent return on thinning investment	—	10.6%	9.9%	(3)
7. Gross income on investment—(item 2 minus 5)	$124	$203	$171	$58
8. Gain or loss in 20-year period attributed to thinning (item 3 minus 5)[4]	—	79	47	—66

[1] Volume and values shown in items 1 and 2 are those derived in table 3.
[2] All costs are based on values shown in table 1.
[3] Negative.
[4] Neither capital gains nor timber price changes are considered in determining gain or loss.

Table 6.—Expected gross per-acre income from growing northern hardwood timber to age 45, with and without thinning on land held solely as an investment in timber production

Item	No thinning	Species thinning	Light thinning	Heavy thinning
1. Average merchantable volume in standard cords/acre[1]	24.5	27.0	25.6	24.9
2. Highest merchantable value from harvesting both pulpwood and boltwood in 20-year period	$124	$260	$216	$131
3. Present value of wood attributable to thinning (item 2 minus $124)	0	136	92	7
4. Average marking and tree-removal cost[2]	0	17.84	13.90	22.76
5. Investment cost for marking and tree removal after 20 years @ 6-percent compound interest rate	0	57	45	73
6. Investment costs of taxes, supervision, and protection after 20 years @ 6-percent compound interest rate	18	18	18	18
7. Investment cost of land after 20 years @ 6-percent compound interest rate	64	64	64	64
8. Total costs (items 5 + 6 + 7)	91	148	136	164
9. Expected gross income on investment (item 2 minus 8)[3]	42	121	89	—24

[1] Volume and values shown in items 1 and 2 are those derived in table 3.
[2] All costs are based on values shown in table 1.
[3] Neither capital gains nor timber price changes are considered in determining gain or loss.

Another point of view we want to illustrate is that of an owner who will not continue to hold his forest land unless the timber-management activities *alone* will provide an acceptable return on investment. In this illustration of the economics applied to our thinning study, we used the costs shown in table 1 and the volume and value data for the various products shown in tables 2 and 3.

First, we illustrate how a multiple-use forest owner might treat these costs. He would consider only those direct costs affecting timber-production activities when selecting an activity or alternative activity. In our analysis, these costs are similar to our timber-marking and tree-removal costs (table 1). Table 5 shows how a multiple-use forest owner might look at an investment in one of the thinning methods.

Now, a single-use investor in timber management might not only consider the thinning-investment cost, but also the fixed costs of protection, taxes, and forest management. These costs are fixed because they will remain the same whether he thins the forest stand or lets nature take its course. Table 6 illustrates this point. These fixed costs *do* enter into the decision to apply a thinning method or to select the best thinning method.

From these illustrations (tables 5 and 6), we can see that precommercial thinning materially increases the volume and value realized from growing northern hardwoods. To maintain this accelerated increase in value, thinning costs must be kept at a minimum. There is every indication that thinning can increase stand growth and quality, but the value of the increases must exceed thinning costs to be profitable.

Thinning Methods

Of the three thinning methods studied, the light crop-tree thinning and the species thinning generally produced higher returns than the heavy crop-tree thinning. The higher returns from these two treatments are due to the fact that very few merchantable trees were removed in these thinnings; relatively few trees of any kind were removed in the light

thinning, and all trees removed in the species thinning were noncommercial tree species. Thus residual stands treated by light or species thinning contained more volume than did residual stands treated by heavy thinning. Although growth rate of the residuals was highest after heavy thinning, this was not enough to offset the lower residual volume and higher treatment costs during the 20-year time span considered here. However, the heavy treatment shows promise of outperforming the others over a longer time span.

After random assignment of plots to treatments, it was found that the heavy-thinning plots had fewer paper birch trees in the 5- to 8-inch d.b.h. classes than the other three treatments (61 versus 90 to 104). Since paper birch represents the major part of the yields reported here, this initial difference in stocking has tended to reduce the early yields on the heavy thinning plots more than they would have been had all plots had equal initial stocking. No adjustments in the data and discussion have been made for this difference.

Differences in tree-removal costs and the greater volume in larger trees also account for the better performance of light thinning than species thinning for some of the comparisons. However, we must recognize that under certain market criteria, species thinning would be preferred because this thinning method leaves more merchantable birch and ash trees in the stand than the light crop-tree thinning. The considerably higher cost of tree removal in the species thinning is more than offset by the better growth rate achieved by this thinning.

However, the difference in rate of return between these two treatments was generally small. In fact, when costs of marking timber and tree removal are included, the species-thinning investment return is 10.6 percent as compared to 9.9 percent for the light thinning (table 5).

CONCLUSIONS

The desirability of an investment in precommercial thinning in young northern hardwood stands depends upon the product goals and the time periods under consideration. Where pulpwood or other low-value products are to be grown on short rotations, investments in precommercial thinning are seldom justified.

But where high-value products such as large and small boltwood are to be grown over a long enough rotation to achieve large trees of high quality, investments in precommercial thinning frequently produce 6 percent or more return on investment. Precommercial thinning investments are particularly attractive on areas where timber production is the major land use.

Of the several thinning methods analyzed in this study, the light crop-tree and species thinning offered an investment advantage over the heavy-thinning method. This was due to the fact that the initial thinning costs are low for the light thinning and that there were no marking costs in the species thinning. In addition, relatively few trees of commercial species were removed in the light and species thinnings, so that a commercial thinning is possible somewhat earlier than in the other treatments. Growth rates were better in both the species thinning and the heavy crop-tree thinning, and crown closure will probably occur sooner in the light thinning. There is some indication that these factors will be important enough to offset the lower treatment costs of the light thinning.

Since initial treatment costs and the volume in merchantable non-crop trees were such important factors, it seems likely that a reduction in the number of crop trees selected would be advisable. If 200, rather than 400, crop trees were selected and the stand was thinned, there would still be more than enough crop trees at maturity, costs of precommercial thinning would be reduced, more non-crop trees would be available for an early commercial thinning, and the costs and benefits of the thinning would be concentrated on those few stems that will be carried long enough to yield high-value products. Such a thinning should combine the silvicultural advantages of a heavy thinning with the economic advantages of lower initial cost and higher residual stand volume.

APPENDIX

Table 7.—Average number of trees per acre on all thinning plots, by species and diameter class, before thinning

Diameter class (inches)	Paper birch	Yellow birch	White ash	Sugar maple	Red maple	Beech	Aspen	Conifers	Others[1]	Total trees/ acre
1	85	248	32	807	80	759	1	25	205	2,242
2	112	142	26	159	48	213	5	23	287	1,015
3	78	61	18	40	25	41	7	6	179	455
4	61	20	13	8	18	3	8	3	70	204
5	41	2	3	1	3	1	7	1	15	74
6	21	1	1	1	1	—	10	—	2	37
7	7	—	—	—	—	—	4	—	1	12
8	1	—	—	—	—	—	3	—	—	4
9	—	—	—	—	—	—	1	—	—	1
10	—	—	—	—	—	—	1	—	—	1
11	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—
Total	406	474	93	1,016	175	1,017	47	58	759	4,045

[1] Others consisted mainly of pin cherry and striped maple.

Table 8.—Average number of crop trees per acre on all thinning plots, by species and diameter class, before thinning

Diameter class (inches)	Paper birch	Yellow birch	White ash	Sugar maple	Red maple	Beech	Others[1]	Total trees/ acre
1	—	—	—	—	—	—	—	—
2	14	14	3	28	4	11	—	74
3	38	32	8	33	6	9	—	126
4	41	18	12	9	8	3	1	92
5	40	4	6	2	2	—	—	54
6	24	1	1	1	1	—	—	28
7[2]	11	—	—	—	—	—	—	11
8	2	—	—	—	—	—	—	2
Total	170	69	30	73	21	23	1	387

[1] Others consisted mainly of conifers.

[2] Discrepancies in total and crop-tree stand tables occur because in some cases the crop trees were selected one growing season after original inventory.

Table 9.—The diameter growth in inches of selected crop trees by diameters and precommercial thinning method for the first 5 years after thinning

Crop-tree diameter (inches)	Thinning method			
	None	Light	Species	Heavy
		PAPER BIRCH		
2	0.11	0.20	0.44	0.53
3	.36	.37	.55	.63
4	.62	.65	.68	.72
5	.82	.88	.85	.94
6	.98	1.07	1.06	1.13
		YELLOW BIRCH		
2	.21	.27	.30	.55
3	.39	.48	.45	.69
4	.58	.66	.60	.88
5	.68	.80	.86	1.05
6	.85	.91	1.00	1.16
		WHITE ASH		
2	.50	.44	.59	.82
3	.68	.67	.70	.91
4	.86	.90	.87	1.07
5	1.00	1.10	1.14	1.18
6	1.12	1.28	1.51	1.25
		SUGAR MAPLE		
2	.10	.27	.46	.45
3	.28	.46	.63	.66
4	.67	.85	.85	.85
5	1.00	1.10	1.00	1.00
6	1.17	1.24	1.10	1.15
		RED MAPLE		
2	.35	.18	.46	.34
3	.60	.34	.66	.50
4	.79	.72	.96	.70
5	.86	1.11	1.08	1.60
6	.92	1.33	1.15	1.75
		BEECH		
2	.23	.26	.27	.60
3	.34	.43	.47	1.00
4	.49	.62	.77	1.22
5	.66	.82	1.00	1.34
6	.82	1.02	1.12	1.42

Table 10.—Average number of crop trees, by volume, for each thinning practice, by 5-year period for all plots[1]

Species	1959		1964		1969		1974		1979	
	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume
	No.	*Cords*	*No.*	*Cords*	*No.*	*Cords*	*No.*	*Cords*	*No.*	*Cords*
					NO THINNING					
Paper birch	196	1.3	191	3.0	191	5.6	191	8.4	191	11.7
Yellow birch	69	+	69	.1	69	.2	69	.5	69	.9
White ash	12	.1	12	.1	12	.2	12	.4	12	.7
Sugar maple	69	—	69	+	69	.1	69	.3	69	.5
Red maple	21	+	21	+	21	.2	21	.4	21	.7
Beech	19	—	19	—	19	—	19	—	19	+
Others	6	—	6	+	6	.1	6	.1	6	.2
Total	392	1.4	387	3.2	387	6.4	387	10.1	387	14.7
					LIGHT THINNING					
Paper birch	170	2.1	170	4.6	170	7.7	170	11.3	170	15.3
Yellow birch	52	+	44	.1	44	.2	44	.4	44	.8
White ash	24	+	24	.2	24	.6	24	1.3	24	2.0
Sugar maple	96	+	95	.1	95	.4	95	1.1	95	2.0
Red maple	8	—	8	+	8	.2	8	.3	8	.5
Beech	30	—	30	—	30	+	30	.1	30	.2
Others	1	+	1	+	—	—	—	—	—	—
Total	381	2.1	372	5.0	371	9.1	371	14.5	371	20.8
					SPECIES THINNING					
Paper birch	166	1.4	165	4.0	165	7.0	165	10.5	165	14.4
Yellow birch	82	—	82	.1	82	.4	82	.9	82	1.6
White ash	42	—	42	.3	42	1.1	42	2.1	42	3.6
Sugar maple	48	+	48	+	48	.1	48	.4	48	.8
Red maple	29	.1	29	.2	29	.6	29	1.1	29	1.7
Beech	36	+	37	+	37	.1	37	.3	37	.5
Total	403	1.5	403	4.6	403	9.3	403	15.3	403	22.6
					HEAVY THINNING					
Paper birch	146	1.0	146	2.7	146	5.0	146	7.9	146	11.0
Yellow birch	75	+	74	.1	74	.5	74	1.2	74	2.1
White ash	46	.1	46	.5	46	1.5	46	2.8	46	4.5
Sugar maple	79	+	80	.1	80	.6	80	1.3	80	2.4
Red maple	26	—	26	.2	26	.9	26	1.7	26	2.7
Beech	10	—	10	—	10	—	10	.1	10	.2
Total	382	1.1	382	3.6	382	8.5	382	15.0	382	22.9

[1] Mortality was not considered in crop-tree projections.

Table 11.—Average number of trees (total stand) by volume for each thinning practice by 5-year period for all plots

Species	1959		1964		1969		1974		1979	
	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume	Average trees/ plot	Volume
	No.	*Cords*	*No.*	*Cords*	*No.*	*Cords*	*No.*	*Cords*	*No.*	*Cords*
					NO THINNING					
Paper birch	494	1.1	362	3.6	268	6.8	200	10.2	177	14.3
Yellow birch	521	+	357	.2	249	.5	177	.9	128	1.7
White ash	31	+	22	.1	15	.2	11	.5	11	.8
Sugar maple	864	—	644	+	482	.1	363	.4	274	.7
Red maple	185	+	118	+	76	.3	50	.6	33	1.0
Beech	1,068	+	816	.1	633	.1	498	.2	398	.3
Conifers	138	—	117	.1	99	.2	84	.3	72	.5
Aspen	47	.9	41	1.8	36	2.8	34	4.0	34	5.2
Others	906	+	275	.1	—	—	—	—	—	—
Total	4,254	2.0	2,752	6.0	1,858	11.0	1,417	17.1	1,127	24.5
					LIGHT THINNING					
Paper birch	374	1.3	235	4.6	165	7.8	141	11.5	137	15.3
Yellow birch	278	.1	170	.2	111	.3	74	.6	52	1.0
White ash	62	+	46	.2	36	.6	30	1.3	26	2.0
Sugar maple	1,350	.1	985	.2	747	.6	572	1.4	443	2.4
Red maple	70	+	28	+	18	.2	12	.3	10	.5
Beech	1,016	—	820	+	658	.1	534	.2	436	.4
Conifers	18	—	17	+	14	+	13	.1	12	.2
Aspen	70	.9	30	1.0	27	1.9	26	2.8	26	3.8
Others	671	+	123	.1	—	—	—	—	—	—
Total	3,909	2.4	2,454	6.3	1,776	11.5	1,402	18.2	1,142	25.6
					SPECIES THINNING					
Paper birch	345	1.1	281	4.5	229	8.2	188	12.5	182	17.2
Yellow birch	456	+	326	.1	235	.6	170	1.1	125	2.1
White ash	115	—	88	.3	70	1.1	60	2.1	53	3.6
Sugar maple	874	—	655	+	493	.1	373	.5	283	1.0
Red maple	202	.1	91	.2	57	.6	42	1.2	31	1.8
Beech	1,175	—	1,003	+	858	.1	734	.5	630	1.0
Conifers	26	+	23	.1	21	.1	20	.2	18	.3
Aspen	16	.5	—	—	—	—	—	—	—	—
Others	874	+	19	—	—	—	—	—	—	—
Total	4,083	1.7	2,486	5.2	1,963	10.8	1,587	18.1	1,322	27.0
					HEAVY THINNING					
Paper birch	409	.8	238	2.7	175	5.1	137	8.0	121	11.1
Yellow birch	638	.1	387	.1	276	.5	203	1.4	154	2.4
White ash	161	.3	80	.5	54	1.5	40	2.7	39	4.4
Sugar maple	980	.1	725	.1	574	.6	455	1.4	362	2.5
Red maple	248	—	110	.2	70	1.1	46	2.0	35	3.2
Beech	810	—	675	—	557	+	463	.2	387	1.1
Conifers	51	.1	38	.1	30	.1	22	.1	18	.1
Aspen	58	.6	3	+	2	+	2	+	2	.1
Others	586	—	51	—	—	—	—	—	—	—
Total	3,941	2.0	2,307	3.7	1,738	8.9	1,368	15.8	1,118	24.9

*U.S. GOVERNMENT PRINTING OFFICE: 1972-708-041/387

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by John C. Bjorkbom

Ten-Year Growth of PLANTED PAPER BIRCH in Old Fields in Maine

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-246
1972

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

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MANUSCRIPT RECEIVED FOR PUBLICATION 2 FEBRUARY 1972

EARLY RESULTS of planting paper birch in old fields in Maine have not been very encouraging. Observations of seven plantations in a study established in 1959 by the Northeastern Forest Experiment Station showed low survival and slow growth over the first five growing seasons *(1)*. Removing the sod in advance of planting gave better results than planting directly in the sod.

During the next five growing seasons, the number of survivors continued to decline, but at a much slower rate. Despite improved growth in this period, most of the surviving trees were relatively small. One-half to two-thirds of the stems fell below the 1-inch diameter class, and 60 to 78 percent were less than 10 feet tall. And since the crowns had not closed, natural pruning was at a minimum.

STUDY METHODS

The plantations in this study were established in the spring of 1959 by the Northeastern Forest Experiment Station in cooperation with the Maine Hardwood Association. Seven planting sites were selected in old fields in western Maine. These sites were either level or sloped gently to the south. Elevations ranged from 400 feet to 1,000 feet. Soils were mostly well-drained sandy loams. Three of the planting sites were actively used for haying or pasturing until planted. The other sites had been abandoned from agricultural use for a varying number of years.

Each plantation was about ½ acre in area. Planting was done at 6x6 spacing. The planting stock was 2-0 seedling stock of fair quality.

Four treatments were tested, each representing a different combination of site preparation, planting method, and planting position. These treatments were:

1. **Furrow slice.**—A plowed double furrow with the second slice turned over into the first furrow, trees hand-planted on the second slice (fig. 1).
2. **Furrow bottom.**—A plowed single furrow, trees hand-planted in the bottom of the furrow.

Figure 1.—In the furrow slice treatment, seedlings were hand planted on top of the second overturned slice of a double furrow.

3. **Scalp.**—Scalps 16 inches wide made with attachments to a Lowther planting machine, trees machine-planted in the center of the scalped strip. In practice, the scalps were not always full width because the blades fouled with debris.
4. **Sod.**—No sod removal, trees machine-planted directly in the sod.

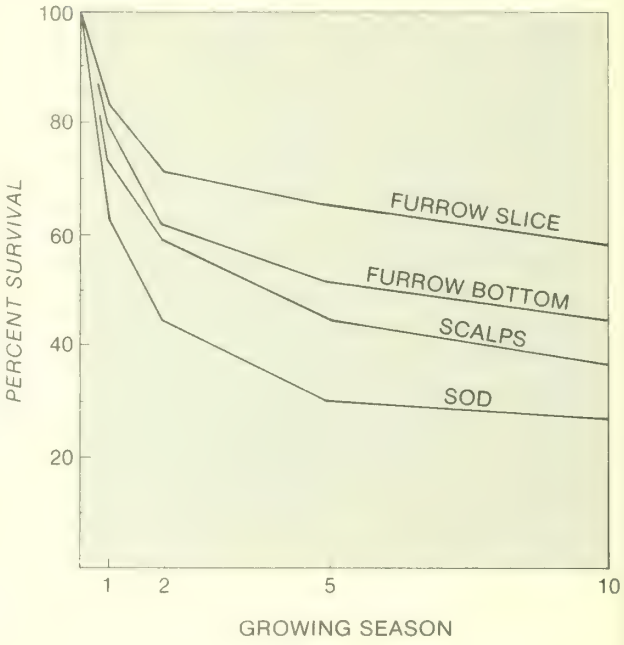
Since hardwood plantings are subject to animal damage, a test of repellents that protect seedlings from damage by deer, rabbits, hares, and mice was incorporated in the main study. These repellents were applied in spring and fall. However, they were ineffective because of the long intervals between applications and because of the relatively high animal pressure at the time the plantations were established.

Repellents were not used after the spring of 1960. Instead, a mouse-control program using

poisoned baits was carried out in the fall of 1960 and 1961 by the Division of Wildlife Services of the U. S. Department of the Interior. Since this program was set up to protect the seedlings rather than as a study of mouse control, the degree of control could not be evaluated. Also, seedling mortality and damage had already begun to decrease by the time of the 1960 treatment, and mouse populations were already low before treatment in 1960.

In September 1968, ten growing seasons after planting, the surviving trees in these seven plantations were remeasured to find out what changes in survival occurred and how well the survivors grew. Survival was based on an actual count of live trees remaining. Growth was based on height measured to the nearest ½ foot and diameter measured in 1-inch classes.

Figure 2.—Survival of planted paper birch seedlings, by treatment, for the first ten growing seasons.



RESULTS

Survival

After ten growing seasons, survival ranged from a low of 27 percent for seedlings planted in the sod to a high of 58 percent for those planted on the furrow slice. For all plantations combined, survival was best on the furrow slice, followed by survival in furrow bottoms, in scalps, and in sod, in that order (table 1).

In individual plantations, survival was consistently and significantly (at the 5-percent level) lower where the sod was left intact than where it was removed. However, differences among the furrow slice, furrow bottom, and scalp treatments varied from one plantation to another, indicating that the effects of site were greater than the effects of treatment.

Survival showed a continuous decline over the ten growing seasons (fig. 2). Most of the mortality occurred in the first 2 years.

Table 1.—*Ten-year survival of planted paper birch seedlings, by treatment and plantation, September 1968*

Plantation	Treatment			
	Furrow slice	Furrow bottom	Scalp	Sod
	Pct.	*Pct.*	*Pct.*	*Pct.*
1	89	65	53	43
2	88	70	55	46
3	59	52	50	28
4	48	7	19	3
5	43	42	34	29
6	64	72	43	33
7	13	0	0	0
Average	58	44	37	27

Mortality

Planting failure (mortality within 1 month of planting) accounted for about 12 percent of the total mortality in all plantations combined. Although there were differences by plantation, most occurred in the sod and on the furrow slice. Presumably the sod provided excessive competition for the seedlings and also made planting difficult. The furrow slice was also difficult to plant and, in addition, the overturned litter and loosened soil dried quickly. As much as one-fourth of the total mortality in a single plantation was due to planting failure.

Mouse-caused mortality accounted for about 12 percent of the total mortality. Generally,

this was most common in the furrow bottom treatment and more common in scalps or in sod than on the furrow slices. Of this mortality, about 61 percent occurred in the 6-month period (June to October 1959) after planting, and an additional 33 percent occurred during the first winter (October 1959 to June 1960). Mouse-caused mortality accounted for as much as 45 percent of the total mortality in a single plantation and as much as 61 percent of the total mortality in a single treatment (furrow bottom) in one plantation.

Deer were not a factor in mortality; but rabbits, hares, frost heaving, and other factors did kill some seedlings. Seedlings dead because of such factors have been included with those dead from unknown or multiple causes. And these unknown causes accounted for 76 percent of the total mortality in all plantations combined.

Tree Height

For all plantations combined, average height after ten growing seasons was best on the furrow slice. The average heights of seedlings planted in furrow bottoms and in scalps were much alike—and better than those planted in the sod. This pattern of height growth was the same in most of the plantations (table 2). The substantially greater average heights in plantation 3 were probably due to more favorable soil characteristics — a deeper soil, better moisture conditions, and higher fertility.

Table 2.—*Average height of trees, by treatment and plantation, after 10 growing seasons, September 1968*

Plantation	Treatment			
	Furrow slice	Furrow bottom	Scalp	Sod
	Ft.	*Ft.*	*Ft.*	*Ft.*
1	11.8	7.5	7.2	6.4
2	11.3	9.1	9.1	7.6
3	15.6	12.3	13.3	9.6
4	11.7	8.8	8.0	12.6
5	6.1	4.3	4.1	4.3
6	9.6	8.7	8.4	7.0
7	10.6	(1)	(1)	(1)
Average	11.2	8.5	8.6	7.0

[1]No survivors.

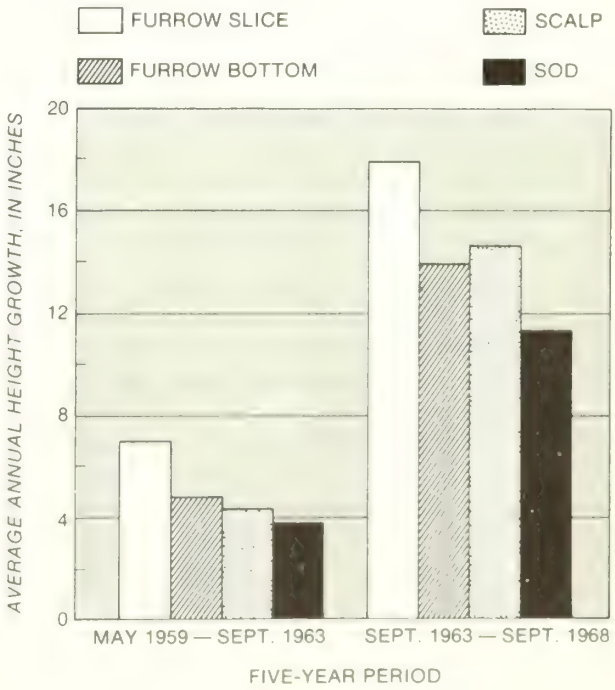
A maximum height of 24 feet was attained on the furrow slice. And although a number of trees were 20 feet tall or taller, these trees represented only 2 percent of the total number of seedlings planted on the furrow slice. The distribution of surviving trees by height class and treatment was:

Treatment	Height class		
	Less than 10.0 feet (pct.)	*10.0-19.5 feet (pct.)*	*20.0 feet and taller (pct.)*
Furrow slice	37	61	2
Furrow bottom	60	40	0
Scalps	62	38	(1)
Sod	78	22	0

[1]Less than 0.5 percent.

Height growth the first 5 years after planting was relatively slow but improved as the seedlings recovered from the initial shock of planting, as they became acclimated to their environment, and as the incidence of deer browsing dropped off. In the second 5-year period, the average annual height growth in each treatment was about three times greater than it was in the first 5-year period (fig. 3).

Figure 3.—Average annual height growth, by 5-year periods after planting.



Tree Diameter

After 10 growing seasons, the largest trees were in the 3-inch diameter class (larger than 2.5 inches and up to and including 3.5 inches measured at breast height). Although few in number, they occurred in all treatments and were most common on the furrow slice.

Small diameter trees were the rule (table 3). One-fourth of the trees planted on the furrow slice and one-half to two-thirds of the trees planted in the other treatments were below the 1-inch diameter class.

Table 3.—*Percent distribution of planted paper birch trees, by diameter class and treatment, after 10 growing seasons, September 1968*

Diameter class (inches)	Treatment			
	Furrow slice	Furrow bottom	Scalp	Sod
	Pct.	*Pct.*	*Pct.*	*Pct.*
<1	26	53	51	68
1	47	39	36	26
2	22	8	12	6
3	5	(1)	1	(1)

[1]Less than 0.5 percent.

Damage

Deer and mice caused about one-half of the total incidence of damage in the first 5 years after planting. About one-third of the damage was due to unknown causes; the remainder was due to rabbits, hares, insects, and weather.

The amount of deer damage was fairly constant over the first few years. Incidence of deer damage appeared to be related to treatment. More browsed seedlings were observed in the furrow slice treatment, followed by the furrow bottoms, the scalps, and the sod in that order and in the ratio of 4:3:2:1. Presumably the seedlings in the furrow slice treatment were more visible and easier to reach because of their position on top of an overturned slice and because of their better height growth.

Most of the mouse damage occurred in the first year after planting; 36 percent between June and October 1959, 45 percent between October 1959 and June 1960. The incidence of mouse damage on seedlings planted on furrow slices or in furrow bottoms was about twice that for seedlings planted in scalps or in sod. The furrowing treatments apparently provided the mice with maximum protection from predators.

The damage resulted from mice feeding on the bark and cambium. Generally this occurred low on the stem. Depending on the size of the wound, seedling vigor was impaired, and damaged stems were more susceptible to breakage at the point of injury.

Few seedlings were damaged by adverse weather conditions in this period, but occasional frost heaving did occur. And in some instances, birch seedlings were broken or bent to the ground when the taller competing herbs collapsed on the seedlings under the weight of snow.

Snow damage occurred in the second 5-year period also. At times the weight of the snow was great enough to break the long lower branches on some of the larger trees. Some of these branches remained attached to the main stem; but others broke off and, in the process, tore a narrow strip of bark from the bole. In addition to the breakage, snow bending occurred. In itself, this was not serious, but the stems and branches bent over to the snow surface were easily reached and stripped of their bark by snowshoe hares.

Tree Form

Where the crowns had not closed, trees were bushy with branches almost to the ground. Only a few places had complete crown closure. Usually this was where furrow slices or furrow bottoms adjoined, and where survival and growth were good. In these limited areas, some natural pruning had taken place. On the best sites, this began about 5 years after planting.

DISCUSSION

The 10-year results of planting paper birch in old fields show that both survival and growth are better where the sod has been removed than where it is left intact. Among the sod-removal treatments, the best results were associated with the furrow slice—a treatment that gave the maximum width of desodded strip. Damage was still a problem, although it was much reduced. By this time, most of the survivors were large enough to escape serious injury from both rodents and deer.

Earlier trials of planting paper birch in old fields in other locations have also demonstrated that survival and growth were better where the sod was removed. In Maine, furrowing gave better sod control than did bulldozing, plowing, harrowing, burning, or herbicides *(6,7)*. In New York, hardwood plantings —including paper birch—failed because the sites were not prepared and the seedlings were not protected *(4)*. Other hardwood species also tend to respond favorably to site preparation *(2,3,5)* and sometimes require cultivation to maintain acceptable survival *(8)*.

The results of this study show that we cannot yet recommend planting paper birch in old fields. If we are to plant successfully in these sites, we need better information for judging site suitability, we must determine the effect of site preparation on the microenvironment, and we must find more effective methods of preventing animal damage.

But if there is a real need or desire to plant in old fields now, select only the best sites, be sure to remove the sod from within about 2 feet of the planting spot, plant carefully, use only the best stock, and provide protection from rodents and deer. In this way, your chances for planting success will be increased.

■

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Are You OVERLOADING Your SKIDDER TIRES?

by Cleveland J. Biller

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-247
1972

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
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MANUSCRIPT RECEIVED FOR PUBLICATION 4 NOVEMBER 1971

THE TIRES USED on most log skidders for Appalachian logging jobs are too small for the loads they have to carry, and most are underinflated.

These were the main conclusions from a study completed at the Forestry Sciences Laboratory maintained by the USDA Forest Service's Northeastern Forest Experiment Station at Morgantown, West Virginia.

The undersize and underinflated tire is one of the costliest problems in Appalachian logging. Overloaded and underinflated tires cause excessive wear and expensive early replacement (fig. 1).

In seeking a solution to this problem, we have developed a method that can be used for choosing the correct tire size and inflation pressure for a particular skidder.

THE STUDY

To study skidder tire performance, we used a Pettibone Master-8 skidder as a test machine. (Mention of a particular make of skidder is for information only, and should not be considered as an endorsement by the Forest Service.) This study was set up to determine what effect different depths of tread have on the amount of load a skidder can pull.

In these tests, we used a tire inflation pressure of 22 p.s.i., even though the manufacturer suggested 16 to 18 p.s.i. for tires of this size. Even at 22 p.s.i., we found that we were

Figure 1. — A typical underinflated and overloaded tire on a log skidder. This kind of abuse leads to serious and costly damage.

overloading the tires. The rear tires were squashing out, which would eventually cause breakdown of the sidewalls. Since a skidder tire may cost $800, this kind of damage can be a serious cost problem for the logger.

This overloading of the tires raised a question: How can you determine the proper size and inflation for skidder tires? To determine this we studied the forces exerted on the tires in relation to the loads to be carried.

THE FORCES ON THE TIRE

A log skidder is a heavy machine. The tires must bear not only the weight of the machine, but also part of the weight of the load carried. And the weight of the machine on the front tires shifts toward the rear tires as the load is applied.

For example, in our study, our loads peaked out at 10,500 pounds line-tension load. At this loading, and on level ground, the machine was hard to steer and the front end began to lift off the ground, throwing the major force onto the rear tires.

So the main force we are concerned with is the normal force on the rear tires. This is made up of three elements (fig. 2):

1. The empty machine weight on the rear tires.
2. The shifting of machine weight onto the rear tires.
3. The part of the load that acts downward onto the rear tires.

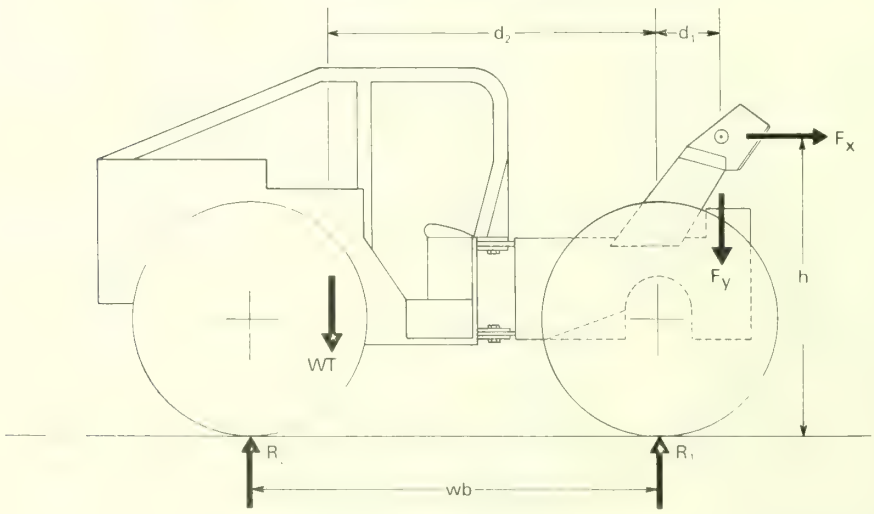
These three elements constitute the total force on the rear tires. It is this total force that must be used as a basis for calculating the proper size of tire and the proper inflation pressure.

CALCULATING THE FORCES

To calculate the forces exerted on the rear tires, we collected data on winch-line pull and angle. A computer was used to get angle of skidder winch line as a least-squares-fit polynominal function of the log load (fig. 3 and fig. 4).

From our data on loads, we assumed 8,000 pounds as a reasonable winch-line load. Using a winch-line angle of 37.5 degrees below the horizontal (fig. 3), and converting the

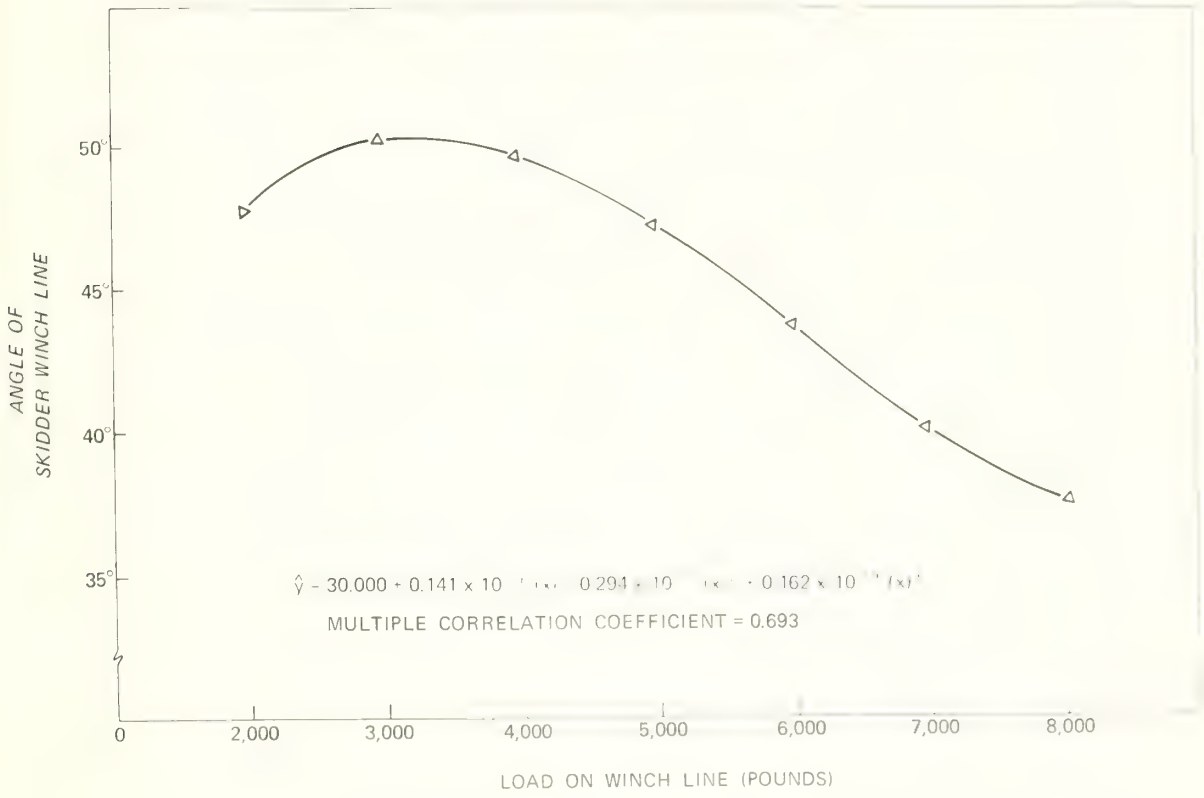
Figure 2. — Diagram of a log skidder, showing the major forces exerted during skidding.



$\Sigma F_y = 0 \quad F_y + WT = R_1 + R_2$

$\Sigma M_{r_1} = 0 \quad F_x(h) - F_y(d_1) + WT(d_2) - R_2(wb) = 0$

Figure 3. — Curve of the regression equation for winch-line angle versus winch-line load. Based on data for a Pettibone Master-8 skidder.



8,000-pound load to a force in the X direction and a force in the Y direction, we have:

$$F_x = F \ (\cos 37.5°) = 8{,}000 \ (0.79335)$$
$$F_x = 6347 \text{ (pounds of force) (lbf.)} \quad (1)$$

$$F_y = F \ (\sin 37.5°) = (0.60876) \ 8{,}000$$
$$F_y = 4870 \text{ lbf.} \quad (2)$$

We also need to know the ground forces, R_1 and R_2 (fig. 2). Summing the forces in the Y direction and setting them equal to zero:

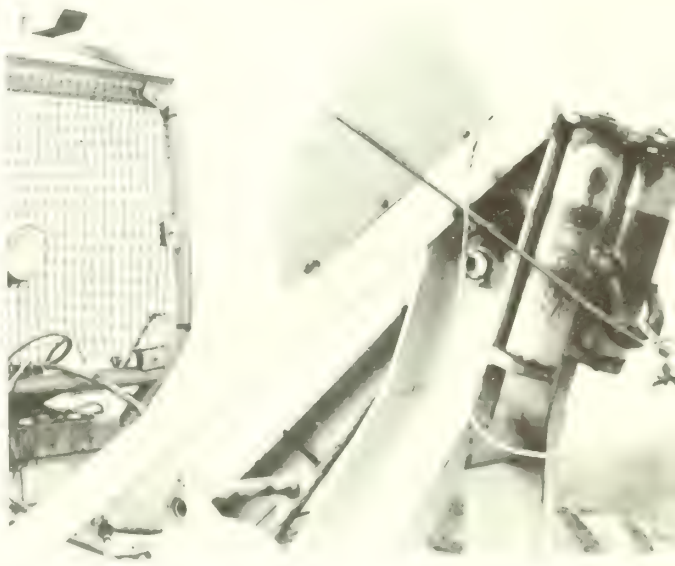
$$\Sigma F_y = 0$$

$$-F_y - W_t + R_1 + R_2 = 0 \quad \therefore \quad (3)$$
$$F_y + W_t = R_1 + R_2$$

Taking moments about the point where R_1 acts and setting them equal to zero:

$$\Sigma M_{R_1} = 0$$
$$-F_x \ (h) - F_y \ (d_2) + W_t \ (d_1)$$
$$- R_2 \ (wb) = 0 \quad (4)$$

Figure 4. — Method used for determining winch-line angle.



Substituting in machine characteristics for the Pettibone Master 8-A skidder used in the tests (table 1) and solving for R_2:

$$R_2 = -F_x(0.80208) - F_y(0.1770) + 10{,}240$$
$$= -6{,}347(0.80208) - 4{,}870(0.1770) + 10{,}240$$
$$= 4{,}287 \text{ lbf. or } 2{,}143 \text{ pounds force on each front wheel.}$$

Substituting the answer from equation 4 back into equation 3 and solving for R_1:

$$R_1 = F_y + 14{,}240 - R_2$$
$$= 4{,}870 - 14{,}240 - 4{,}287$$

Force on rear wheels R_1 = 14,823 or 7,411 lbf. on each rear tire.

This machine was equipped with 10-ply 18.4 x 26 tires. From table 2, we can see that tires of this size cannot efficiently carry a force or load of 7,411 lbf. These tires should be replaced with 12-ply 28.1 x 26 tires, with an inflation pressure of 20 psig.

DETERMINING TIRE SIZE

This method can be used to determine proper tire size and inflation for other makes of skidders. We have applied this method to

Table 1.—*Machine characteristics of log skidders*

Make & model	Wheel base	Fairlead height	Distance from center of rear axle to fairlead roller	Empty weight, front	Empty weight, rear
	Inches	*Inches*	*Inches*	*Lbf.*	*Lbf.*
Pettibone Master 8-A 97 hp.	96	77	17	10,240	4,000
Clark 666 130 hp.	104	73.35	18	8,770	5,980
Can Car C5-BD 97 hp.	101	70.5	19	7,660	5,200
Franklin 130-B 97 hp.	114	78.0	19	8,870	4,010
Taylor S-112 130 hp.	108	80	12.3	8,900	4,400
Timberjack 230 "D" 97 hp.	110	77.5	20.7	8,430	4,770

Table 2.— *Tire-load limits, in pounds, at various inflation pressures*[1]
(Maximum speed 20 mph)

Tire size (inches)	Tire type	Ply rating	Inflation pressures (psig) of —			
			15	20	25	30
16.9-30	LS-1	6,8,10	3,760(6)[2]	4,450(8)	5,070	5,640(10)
16.9-30	LS-2	8,10	3,760	4,450(8)	5,070	5,640(10)
18.4-26	LS-1	8,10	4,230	5,000(8)	5,700(10)	—
18.4-26	LS-2,LS-3	10	4,230	5,000	5,700(10)	—
18.4-30	LS-1	10	4,500	5,330	6,070(10)	—
18.4-34	LS-1,LS-2	10	4,780	5,650	6,440(10)	—
23.1-26	LS-1,LS-2,LS-3	10	6,050	7,160(10)	—	—
23.1-34	LS-1,LS-2	10	6,840	8,090(10)	—	—
24.5-32	LS-1,LS-2,LS-3	10,12	7,350	8,700(10)	9,910(12)	—
28.1-26	LS-1,LS-2,LS-3	10,12	7,010(10)	8,290(12)	—	—
30.5-32	LS-1	12	8,780	10,390(12)	—	—

[1] The Tire and Rim Association, Inc., Akron, Ohio.

[2] Figures in parentheses show ply rating for which underlined loads and inflations are maximum.

Table 3.—*Weight on single rear tire (normal force, in pounds) for different winch-line loads and several makes of skidders*

Winch-line load skidded (lbs.)	Approx. payload (lbs.)	Pettibone Master 8-A	Clark 666	Can Car C5-BD	Franklin 130-B	Taylor	Timberjack 230
2,000	2,962	3,411	4,333	3,949	3,329	3,523	3,739
3,000	4,612	4,126	5,019	4,639	4,006	4,195	4,431
4,000	6,106	4,833	5,692	5,315	4,670	4,858	5,109
5,000	7,344	5,522	6,341	5,966	5,308	5,502	5,762
6,000	8,296	6,180	6,951	6,577	5,907	6,115	6,376
7,000	9,028	6,802	7,524	7,148	6,468	6,695	6,951
8,000	9,740	7,411	8,085	7,708	7,017	7,263	7,514

the six makes of skidders commonly used in Appalachian logging.

For the different skidders, at various winch-line loads, the force on each rear tire is shown in table 3. These forces were derived from table 1 (machine characteristics) and figure 2.

Graphic plots were made for each of the six skidder models, using winch-line load, winch-line angle, and machine characteristics for calculating the vertical force on each rear tire (fig. 5).

To get the approximate weight of the load to convert into cords and board feet, we used twice the F_y (fig. 2) component of the load (table 4), since it was estimated that about one-half of the log was lifted off the ground. For the weight per board feet and the pounds per cord we used 9 pounds/board foot and 9,000 pounds/cord. (Massey-Ferguson Industrial and Construction Machinery Wood Conversion Chart, 1967.)

Bear in mind, however, that figure 5 will yield an *approximate* value. But with this figure you can estimate the force on a skidder tire. Daily production divided by the trips per day will yield the board feet or cords per trip. From the curves for each machine you can get the tire size and inflation pressure needed on that particular machine.

From the figure 5 plots, table 5 was prepared for determining what size tire should be used on different brands of log skidders, using an assumed maximum winch-line load of 8,000 pounds at an angle of 37.5 degrees. This is a realistic winch-line load for a log skidder; and the winch-line load may go a little higher on some operations.

The last two columns of table 5 show the recommended tire sizes and tire inflation pressures, based on tire manufacturer's literature.

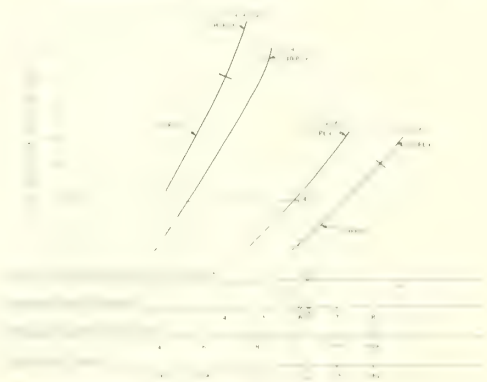
CONCLUSIONS

The logger pays a high cost for using the wrong size of tires on his skidder. The overloaded and underinflated tire breaks down long before it has served its full service life. Then the logger pays the extra cost of having to buy new tires prematurely. By using the information offered in this report, the logger can determine the proper size of tires for his logging job. He can also determine the proper

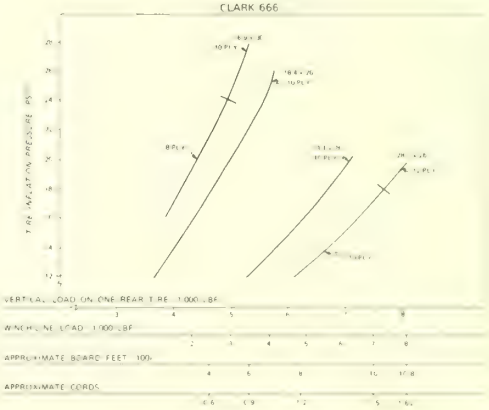
Table 4.—*Approximate board feet or cords per winch-line load of Appalachian hardwoods*

Winch-line load	F_y	Load weight (2 F_y)	Board feet	Cords
2,000	1,481	2,962	329	0.494
3,000	2,306	4,612	512	.769
4,000	3,053	6,106	678	1.018
5,000	3,672	7,344	816	1.224
6,000	4,148	8,296	922	1.383
7,000	4,514	9,028	1,003	1.505
8,000	4,870	9,740	1,082	1.623

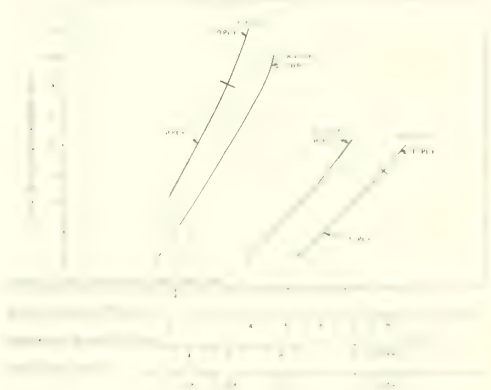
PETTIBONE MASTER 8



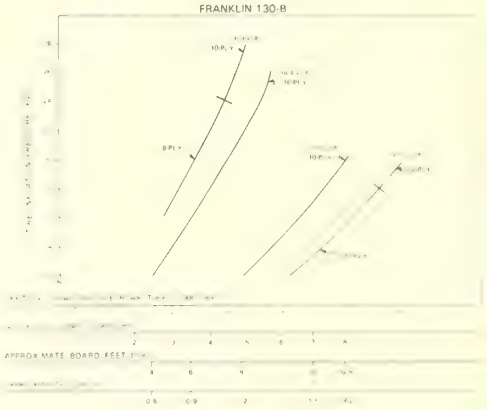
CLARK 666



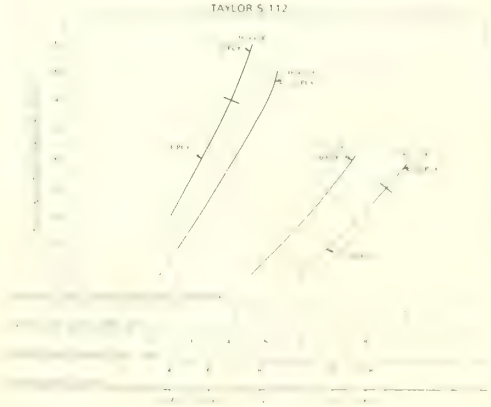
CAN CAR C5 BD



FRANKLIN 130-B



TAYLOR S 112



TIMBERJACK 230

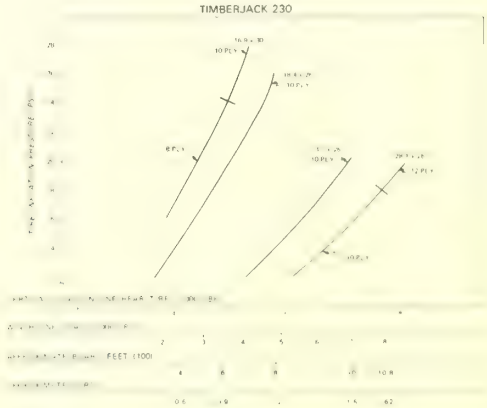


Figure 5.—Graphic plots for determining tire size and inflation pressure, for six makes of log skidders. How to use the plots:

1. Select the plot for your machine. Take the Pettibone Master-8 skidder as an example.
2. On the bottom scale, locate your average cords or board feet skidded per trip. Assume 1.35 cords (1).
3. From this point, extend a line straight up till it strikes the tire-size curve. The tire size in this case would be 10 ply 23.1 x 26. (4)
4. Read left across to the tire-pressure scale. The proper inflation pressure would be about 16 psig. (5)

Where the vertical line crosses the winch-line load scale (2) shows you the winch-line load, in this case about 6,000 lbf. Where the vertical line crosses the vertical load scale (3) shows you the load or force on each rear tire, in this case about 6,100 lbf. You can use this figure to select proper tire size from table 2. (Data for these curves are from the 1970 Tire and Rim Association Yearbook.)

Table 5.—*Recommended tire sizes for assumed load*
(Winch-line load assumed at 8,000 pounds, at winch-line angle of 37.5°)

Make & model	Load on each rear tire	Load on each front tire	Tire size and ply rating	Tire pressure
	Lbs.	*Lbs.*		*Psig.*
Pettibone Master 8-A 97 hp.	7,411	2,144	28.1 x 26 12-ply	20
Clark 666 130 hp.	8,085	1,725	28.1 x 26 12-ply	20
Can Car C5-BD 97 hp.	7,708	1,157	28.1 x 26 12-ply	20
Franklin 130-B 97 hp.	7,017	1,858	23.1 x 26 10-ply	20
Taylor S-112 130 hp.	7,263	1,822	28.1 x 26 12-ply	20
Timberjack 230 97 hp	7,514	1,521	28.1 x 26 12-ply	20

inflation pressure for his tires. And this is important: it is up to the logger to make sure he uses the right inflation pressure to get the best service out of his tires.

Many of the skidders sold today are equipped with tires that are too small. By using the information in this report, skidder manufacturers, sales personnel, and users can determine the proper size of tire for specific load conditions and can properly equip each machine.

If skidders were equipped with the proper size of tires, properly inflated, many of the problems that loggers have with skidder tires would vanish.

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